HEALTH AND DISEASE IN THE TROPICS

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BY

CHARLES WILCOCKS

M.D., F.R.C.P., D.T.M. & H.

Director, Bureau of Hygiene and Tropical Diseases
Formerly Medical Officer and Tuberculosis Research
Officer, Tanganyika Territory

Illustrated by
JOHN HULL GRUNDY
and the AUTHOR

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TO
MY WIFE

PREFACE

This manual is intended primarily, but by no means exclusively, for officers of the Colonial Administrative Service, and is concerned partly with those aspects of public-health work which call for administrative action. But because the understanding of disease, and of its social implications, entails wider knowledge than the bare facts of control, and because understanding is essential to good administration in government and in commercial or social organizations, the known facts concerning distribution, cause, and mode of spread of the diseases have been given in some detail. Moreover, since administrative officers, managers of plantations and mines, and missionaries (to whom the book may also appeal) are often requested to treat the illnesses of people remote from medical attention, descriptions of the clinical features and standard treatments of the various diseases have also been included, together with general advice which will help these officers to preserve their own health and that of their families while living in hot countries.

It is important, however, that those who use this book should realize that it contains no more than an outline of an enormous subject, and that much of the information given is necessarily somewhat over-simplified. Medicine is a complex subject which cannot be condensed into a small compass without some distortion.

In writing this book I have made occasional reference to several text-books. *Manson's Tropical Diseases*, Sir Philip Manson-Bahr, 12th ed. 1945 (Cassell & Co. Ltd., London), *Synopsis of Hygiene* (Jameson and Parkinson), G. S. Parkinson, 8th ed. 1944 (Churchill, London), *Manual of Tropical Medicine*, T. T. Mackie, G. W. Hunter, and C. B. Worth, 1945 (W. B. Saunders Co., Philadelphia and London); *The Sanitary Inspector's Handbook*, H. H. Clay, 6th ed. 1947 (Lewis, London).

The constant flow of recent medical literature which passes through the Bureau of Hygiene and Tropical Diseases, much of which is abstracted in the two periodicals produced by the Bureau, namely, the *Tropical Diseases Bulletin* and the *Bulletin of Hygiene*, has enabled me to include some of the most modern views and

practices, so far as they are relevant to the scope of this book; the main difficulty has been to decide what to leave out.

I am very greatly indebted to Miss W. E. Coventry for typing the manuscript with her customary care and skill.

C. W.

BUREAU OF HYGIENE AND TROPICAL DISEASES
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SECTION 5. PERSONAL PROTECTION AND ORGANIZATION

SECTION I

HEALTH AND DISEASE

CHAPTER I

HEALTH

GOOD health implies full functional activity of body and mind, and depends upon sound body structure and the exercise of physical and mental powers in a favourable environment. Physical structure and mental capacity are largely determined by heredity, but both are also profoundly influenced by environment, and it is with environmental factors that doctors are most closely concerned.

In the preservation of health there are two aspects. The first is the promotion of perfect function by full exercise of the constituent parts of the body and mind as a co-ordinated whole, which has been described as the pursuit of positive health, and which aims at enjoyment of living. The second is the prevention and cure of disease The two are closely linked, but it is the latter with which the public health and curative medical services are most concerned.

One main task of the public health service is to adapt man's environment to his needs and powers, so that disease may be avoided; this adaptation includes all the great public health measures—control of water, food, housing, &c.—which are features of civilized societies. This is an active process of interference with nature, in the interest of man.

Many of the infective diseases to be described later in this book, when they attack a human community, kill a proportion of the victims, and provoke, in those who do not die, a state of more or less efficient immunity. Some of them depend, for their persistence, on a constant supply of non-immune persons—the children, or immigrants from unaffected places—or they are carried from place to place, affecting the susceptible persons. Others, which provoke only relative immunity, produce an uneasy balance between man and the parasites which cause the diseases, and tend to spread or to become more severe when the general health is lowered, as by famine or war. The natural process of immunity is often (but by no means always) sufficient to prevent the individual person from acquiring the disease a second time, but has rarely, if ever, been

able to eliminate a disease from a community. The unhindered processes of nature do not necessarily favour man more than his parasites.

Success in eradication, on the other hand, has been achieved by alteration of environment, by eliminating the causative agent or the transmitting agent of the disease. For instance, cholera has been eliminated from Britain (where there were epidemics in the nineteenth century) because water-supplies have been brought under careful control, and typhus ceased to be a serious problem in several countries during the recent war when means were found of controlling lice. Success has also been achieved by artificial stimulation of immunity, by means of vaccines or other comparable substances, as in smallpox, diphtheria, typhoid fever, yellow fever, and other diseases. In these the immunity is induced under controlled conditions, and the mortality inherent when immunity is induced in nature, by the disease itself, is avoided. It is therefore evident that in relation to these and similar diseases, success in prevention is the outcome of active human effort, interfering with the processes of nature deliberately, in accordance with knowledge at present available.

Apart from the great public health services concerned with water supplies, sewage disposal, prevention of infective diseases, and the like, there is also the important function of maintaining the health of the people by ensuring proper nourishment and facilities for maximum enjoyment of rest, exercise, and fresh air. In these matters the public health services are intimately related to the agricultural, veterinary, and educational services. Another function of the medical departments, especially in the Colonies, is to provide the means for cure of disease—hospitals, dispensaries, clinics, travelling teams—and to train the staff to administer them. In this work the Government is usually very effectively aided by the various religious missions.

To carry out their functions efficiently, the members of the medical staff must be well informed about the common diseases of the country, and about the social and economic customs of the people. For this purpose they must be prepared to collect facts relating to the incidence of the various diseases, and to undertake research. As medical care becomes more adequate, and more easily available to all members of the community, it becomes necessary to collect statistics of the population—births, deaths, cases of dis-

ease—so that there may be a sound foundation on which to judge the effects of any health measures introduced, and to maintain in working order an intelligence service which may give early warning of outbreaks of infective disease. In the collection of population statistics the administrative officer is usually the most important agent, but missionaries, with their intimate knowledge of their people, can make a very accurate contribution to this work It is well known that enumeration of the population of many tropical countries, unless carried out with the greatest care and circumspection, may be rendered useless by the habits of the people In some tribes, for instance, it is not customary for a woman to name her eldest son; the opportunity for error, if questioning is relied upon, is therefore obvious. Before a census is taken, or before any system is devised for the collection of vital statistics, administrative officers and medical officers should read *Vital Statistics and Public Health Work in the Tropics*, by P. Granville Edge (London, Baillière, Tindall, & Cox), in which many of the difficulties of this apparently simple work are discussed. For the purposes of the present book it is enough to state that without a reasonable system of medical book-keeping it is difficult to estimate the health progress of any community; but it remains true that the medical statistics of many tropical countries are still far from reliable.

The medical department may consider desirable certain measures or activities which may contravene the customs of the people. For [illegible]

neither so well informed nor so influential as the administrative officer, and the latter, therefore, should take an active share in all decisions. In such an enterprise, moreover, the agricultural and veterinary officers, the surveyors, the forestry officers, and others, must be consulted if success is to be achieved; it is for the administrative officer to balance the various claims of the other departments, remembering that although he himself is not the expert in the different sciences, he is the expert in handling the people. Control of disease, therefore, may depend for success in some circumstances on the wisdom and ability of the administrative officer.

The administrative officer should constantly bear in mind the

fact that in the more primitive Colonies certain benefits are conferred by Government as a return for the taxes paid by the people. Among these are the suppression of internecine war, the provision of communications, education, the development of agriculture and industry, and the promotion of good health. To a medical man the last is of the greatest importance, and it is, indeed, generally agreed that the development of the medical service is probably the most urgent and the most desirable of Government activities. But the best way to promote good health is usually to strike a balance between the various activities. Good health depends upon adequate nutrition, and usually, therefore, on sound agriculture, both for food and for cash crops; this in turn depends upon education, communications, and peace. Peace brings its own problems; it may lead to over-population and over-stocking, or, as in Nigeria, may be the reason for the spread of the people away from the clearings *round the walled towns and into the bush country along* the rivers, and a consequent outbreak of sleeping sickness. Good health may depend upon industrial prosperity, but industry usually introduces hazards to health which require strict care and legislation (for instance in the mining industry) if the health of the labourers is to be maintained

In all these questions administrative officers and officers of other departments have one overriding duty, to promote the welfare of the people; the preservation of good health, and the reduction of disease, are of paramount importance in welfare.

CHAPTER II

THE CAUSES OF DISEASE

DISEASE, which is physical or mental imperfection, may be due to several groups of causes. In the first place, there may be congenital defects, such as hare-lip or cretinism, which are due to some failure of normal development. Such diseases are not preventable, so far as we know, except perhaps by selective breeding, and the only action a health service can take in relation to them is to supply facilities for treatment.

Certain diseases are due to faulty working of the organs, and are apparently related to an inherited tendency, though it is also prob- [illegible] health measures, but are susceptible of treatment

Certain diseases are related to external conditions—climate, industrial environment, &c.—and these conditions can sometimes be modified.

Certain diseases are the result of improper nutrition, and nutrition may be faulty either in quantity (as in famine) or in quality (as in certain protein-deficiency or vitamin-deficiency states). It is very probable that minor degrees of faulty nutrition, not bad enough to cause the well-known deficiency diseases, are responsible for much vague ill-health; but proof that this is so is very difficult to obtain. Some diseases due to malnutrition are discussed in Chapter XVII below

Certain diseases are due to poisoning by animals, plants, or [illegible] man to man or from animals to man. This is the most important group from the point of view of the public health services, because these diseases can be prevented, and many of them can be successfully treated.

The communicable diseases are due to living parasites which invade the human body, take their sustenance from it, and in that process poison it to a greater or lesser degree, or disturb its structure

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Certain diseases are due to faulty working of the organs, and are apparently related to an inherited tendency, though it is also probable that external conditions play a part in precipitating them. Such diseases are diabetes, gout, some forms of kidney and heart disease, and others. They are not preventable by general public health measures, but are susceptible of treatment.

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The communicable diseases are due to living parasites which invade the human body, take their sustenance from it, and in that process poison it to a greater or lesser degree, or disturb its structure

most commonly found. A child infected for the first time with malaria experiences an attack of the disease; if no specific treatment is given, the child either dies, or, after a long period of fever, gradually recovers But the child is usually not able to eliminate the parasites, and is liable to recurrence of fever; there is only partial immunity. If, now, the child is again infected with parasites of the same kind, he will experience another attack, probably less severe than the first, and if he recovers, his immunity will be strengthened, but still incomplete. Further infections will gradually build up the immunity, with less and less fever, until, if the infections take place sufficiently often, the child no longer becomes ill, though malaria parasites are still present in his blood. This is the stage of immunity as we see it in malaria; it soon falls away, and unless the infections are frequently repeated (several times a year), the immune state deteriorates and new infection, when it does occur, causes fever and illness. This process is continually happening in Africa and other highly malarious countries. It is interfered with by full treatment with quinine and other drugs, which, by destroying the parasites, prevent the stimulation of immunity. For this reason Europeans, who treat fever with drugs, rarely become immune, they are wise to treat themselves, because in the process of acquiring immunity there is serious risk of death, and many infants and children of the indigenous peoples die of malaria in those countries. On the other hand, very small doses of drugs may avert death without seriously interfering with immunity, but the immunity will not be achieved without frequent attacks of fever.

The reader will understand, from what has been said, that epidemiology, which is the knowledge of how diseases spread, is a complicated subject. A disease, introduced into a community, is affected by such factors as the density of population, its industries, state of nutrition, housing and water-supplies, its state of immunity and standard of education, by climatic and seasonal factors, and, if an insect vector (carrier) of the disease is involved, by the climatic and other conditions which affect the insect. In the prevention of the infective diseases, these and similar factors must be taken into account.

It has been stated above that the communicable diseases of man are due to parasites. Some of these are passed directly from man to man or from animals to man; others are transmitted from man

(or other animals) to insects and thence again to man; others pass from man to other hosts such as snails, fishes, pigs, or cattle, and thence back to man. These parasites are of several different groups It is evident, therefore, that a classification of the communicable diseases is possible, either according to the groups of parasites concerned or according to the manner in which the infection is transmitted. Experience has shown that control of many of these diseases is most likely to be successful if an attack is made on the insect or other carriers, and in this book, therefore, some attempt will be made to classify the diseases by mode of transfer as well as by biological grouping. For proper understanding it is necessary that these groups of parasites should be described.

The parasites which cause human disease are all living organisms (though it must be confessed that the status of the viruses is not clearly known). This is important. It means that they are composed of protoplasm, and that their constitution is not very different from the constitution of the animals, including man, on which they prey. It will therefore be understood that to find a drug which is poisonous to the parasite and yet harmless to man, is not easy. Moreover, in the process of evolution, the parasites which have come into being, and survived, have evidently shown considerable power of resistance to adverse conditions, the task of eradicating these parasites is, therefore, not likely to be simple

These parasites are either animals (the worms and the protozoa), plants (the fungi and the bacteria), or of doubtful status (the rickettsiae and the viruses).

The *worms* are divided into three groups. the flukes, the tapeworms, and the round worms. The flukes are flat worms which vary in size; the liver fluke is almost the size of a penny; the fluke which causes schistosomiasis is about ½-inch long but is very slender. The tapeworms are flat and segmented; the largest may be 10 feet or more in length and contain hundreds of segments, the smallest has 4 segments only The round worms are cylindrical (which differentiates them from the first two groups); the longest measures several feet, others are the size of big earthworms; the smallest are as fine as thread and no more than ½-inch long

Many of the worms pass part of their life in man and part in some other animal, and without this dual (in some cases triple) cycle, reproduction is not possible. The cycles of the various worms will be dealt with later, in the appropriate sections, they are

drink the contaminated water or eat the contaminated food. The diseases concerned are worm diseases in which eggs are passed in the faeces (*Ascaris*, threadworms), protozoal diseases (amoebic dysentery), and bacterial diseases (typhoid fever, cholera, bacillary dysentery). One worm disease is acquired, not so much through drinking contaminated water, as by bathing in it (schistosomiasis); in one form of the disease the eggs of the worm are passed out in the urine, and water contaminated with urine is therefore unsafe. But schistosomiasis cannot be transmitted until the worm has undergone a part of its life cycle in certain snails; this process will be described later. Diseases of this group are therefore *water-borne* or *food-borne*; most of them are intimately bound up with human excretions Certain food-borne diseases, however, are linked with diseases of animals Tapeworm infestation is due to eating infected meat, undulant fever to drinking milk from infected goats or cattle, &c.

4 If the parasites are in the blood or the tissues of the patient and have no natural outlet to the exterior, they cannot be transmitted unless some agent pierces the skin, removes blood or tissue fluid, and injects the parasite into another person or animal. The agents capable of thus transmitting these diseases are the biting insects which attack man as a source of food, and transmit his diseases as it were by accident. The diseases concerned are: worm diseases (filariasis, conveyed by mosquitoes and certain flies), protozoal (malaria conveyed by mosquitoes, sleeping sickness by tsetse flies, and others), bacterial (plague carried by fleas), rickettsial (typhus carried by lice, fleas, ticks, or mites), and virus diseases (yellow fever and dengue carried by mosquitoes, and others). These are some of the *insect-borne* diseases. This is a most im-

For instance, malaria is transmitted in nature only by female mosquitoes of the genus *Anopheles*; although other mosquitoes, and many flies, suck blood, they cannot transmit human malaria. Similarly, sleeping sickness is not transmitted by mosquitoes, but only by tsetse flies (and exceptionally by certain other biting flies). Yellow fever is transmitted by mosquitoes, but these are not the mosquitoes that transmit malaria (with one exception). One form of filariasis is transmitted by a large variety of mosquitoes. The second phenomenon is that many of the parasites must undergo a

definite cycle of development in the body of the biting i
before the insect is capable of passing on the parasites to an
human being. This is true of malaria parasites, the trypanos
of sleeping sickness, filarial worms, and other parasites. The
of development in the insect may require 10 days or more f
completion.

5. This list does not exhaust the modes of transmission of [illegible]

[illegible]

diseases, before the diagnosis has been made; yet many dis [illegible]

[illegible]

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borne diseases is still in its very early stages; the methoc
known, in many diseases, but the scale on which they shou
applied is so enormous that only the fringe of the problem h
been touched.

SECTION 2

COMMUNICABLE DISEASES

CHAPTER III

PROTOZOAL DISEASES: INSECT-BORNE

Malaria

Distribution. Malaria is found throughout most parts of the tropics and sub-tropics, and in many temperate countries; it is the commonest disease in the world.

[illegible]

spring, at intervals of about 48 or 72 hours. Some of these offspring develop into male and female types, which are not capable of further development unless they are taken up into the stomach of a female mosquito of the genus *Anopheles*. If they are so taken up, under suitable conditions, these male and female forms of the malaria parasites fuse to form one body, which later divides into many hundreds of small forms (the sporozoites) which make their way to the salivary glands of the mosquito. From these glands they are injected into the next person bitten by that mosquito; for the ejection of saliva, before sucking blood, is a feature of biting insects. The process of development in the mosquito occupies a week or more, depending chiefly on the temperature of the atmosphere.

The malaria parasites are of several species. *Plasmodium vivax* is the parasite of benign tertian malaria, so called because it is not often fatal, and because the bouts of fever, which correspond to the splitting of the parasites, recur at intervals of about 48 hours—i.e. every third day. *Plasmodium falciparum* is the parasite of malignant tertian (or subtertian) malaria, so called because it is not uncommonly fatal, and has a periodicity of about 48 hours. *Plasmodium malariae* is the parasite of quartan fever, so called because its periodicity is of about 72 hours; it is a relatively mild infection. *Plasmodium ovale* is a rare tertian parasite, and the disease is mild.

Plasmodium vivax is found both in temperate climates and in the

tropics, as is *P. malariae*; *P. falciparum* occurs chiefly in the tropics; *P. ovale* is rarely found, but has been reported from India, Africa, and South America.

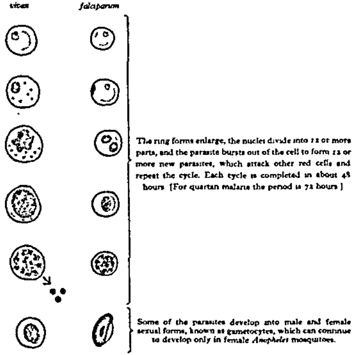

FIG. 1. Malaria parasites. Magnified 1,000 times. Development in red blood cells.

(The red cells become enlarged in *P. vivax* infection.)

Transmission. Some 80 or more species of *Anopheles* mosquitoes are capable of transmitting these parasites; the most dangerous anophelines are those which are particularly attracted to human blood, the least dangerous are those which prefer animal blood. All female mosquitoes lay their eggs in water, and can only

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Cause. Malaria is caused by parasites of the genus *Plasmodium,* which attack the red blood corpuscles, and which reproduce themselves in the human body by a process of splitting into 6–24 offspring, at intervals of about 48 or 72 hours. Some of these offspring develop into male and female types, which are not capable of further development unless they are taken up into the stomach of a female mosquito of the genus *Anopheles.* If they are so taken up, under suitable conditions, these male and female forms of the malaria parasites fuse to form one body, which later divides into many hundreds of small forms (the sporozoites) which make their way to the salivary glands of the mosquito. From these glands they are injected into the next person bitten by that mosquito; for the ejection of saliva, before sucking blood, is a feature of biting insects. The process of development in the mosquito occupies a week or more, depending chiefly on the temperature of the atmosphere.

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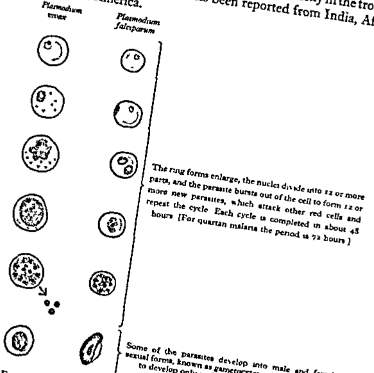


FIG 1 Malaria parasites Magnified 1,000 times Development in red blood cells.
(The red cells become enlarged in *P vivax* infection.)

Transmission. Some 80 or more species of *Anopheles* mosquitoes are capable of transmitting these parasites; the most dangerous anophelines are those which are particularly attracted to human blood, the least dangerous are those which prefer animal blood. All female mosquitoes lay their eggs in water, and can only breed, therefore, where water exists. But their preferences are very diverse; some *Anopheles* prefer clear streams, some stagnant pools, some lay eggs in rain-water in tins, roof gutters, coco-nut shells, or even in road puddles and hoof marks. Some prefer water open

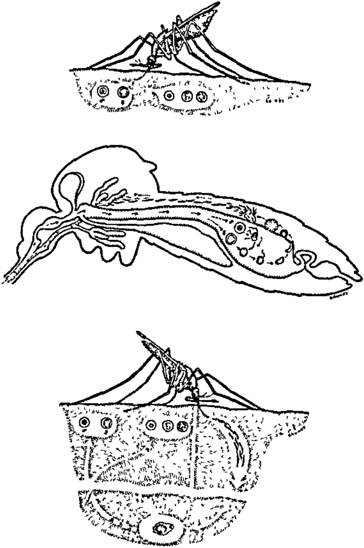


FIG 2 The malaria cycle.

Diagrammatic The sizes of the parasites and mosquitoes are not in proportion to each other

The female *Anopheles*, in feeding on a person with malaria, takes in blood containing the male and female gametocytes

The male and female gametocytes fuse in the stomach of the mosquito, to become a single fertile egg-like body, which develops in the stomach wall, producing large numbers of sporozoites, which make their way to the salivary glands This cycle lasts 7 days or more

When, after the development of sporozoites, the infected mosquito feeds again on man, she discharges sporozoites into the human tissues, these may be detected in the blood for not more than ½ hour after the mosquito has bitten Thereafter they develop in the cells of the liver, and the malaria parasites to which they give rise may be found in the blood 7 to 9 days after the bite of the infected mosquito. The clinical attack of malaria usually begins within a day or two of their appearance in the blood Exceptionally, in *P vivax* infection, this process of development may be delayed for several weeks or months

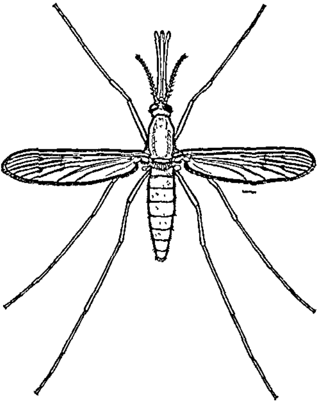


FIG 3 *Anopheles* mosquito (female). Magnified 10 times
Note dappled wings, and the proboscis flanked by two long palps, and by two antennae bearing a few hairs

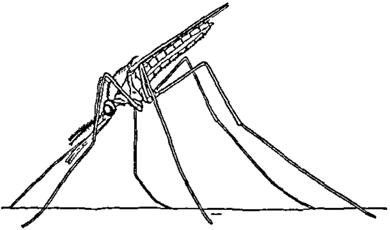


FIG. 4 *Anopheles* mosquito (female) resting position (body at an angle to the surface). Magnified 10 times

n, others need water shaded from the sun. Some seek ntaining a fairly high concentration of salt, others cannot salty water. These preferences are of the utmost practical nce in malaria control, as will be discussed below heles mosquitoes are generally inactive in the day-time, but s dusk, or later until dawn, the females seek their blood the males do not feed on animals or man A blood meal i-

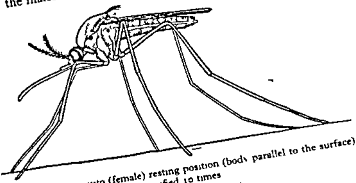


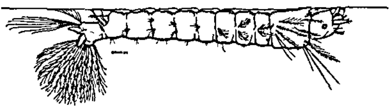
FIG 5 *Culex* mosquito (female) resting position (body parallel to the surface) Magnified 10 times
(*Aëdes* adopts a similar position.)

essential to the reproductive process of the females, and malaria is spread accidentally in the process of feeding. The mosquito is somewhat adversely affected by infection with the malaria parasite, but not usually very severely, in other words, many infected female *Anopheles* live long enough to take a second blood meal several days after the first, and if they pick up the infection at their first blood meal, and if a long enough period elapses for the development of the parasite in them, they are able to pass on the infection to a new host at the second or subsequent blood meal At least two blood meals, therefore, are essential to this process; the mosquito does not pass on the malaria parasite to her offspring

When the female *Anopheles* has laid her eggs in water, the eggs are held on the surface by means of tiny floats. Within a few days, if the temperature is suitable, there hatch out from these eggs the small, active larvae, which can easily be seen by the naked eye. These larvae swim vigorously in search of the small particles of organic matter on which they feed, and usually find them just below the water surface. But the larvae are air-breathers, and must

therefore rise completely to the surface of the water at frequent intervals to renew their supply of oxygen. If the surface of the water is covered with oil, the oil enters the air passages of the larvae, disturbing the process of breathing, and, if it is a toxic oil,

FIG 6.
a Anopheles eggs Magnified 20 times
The eggs have floats; they are laid in water singly or in 'rosettes'.



b Anopheles larva Magnified 20 times.
The larva lies parallel to the surface of the water when breathing, it swims just below the surface for its food

poisoning and killing the larvae. This is the basis of one of the most common measures devised to prevent the breeding of *Anopheles* and other mosquitoes.

After a few days' growth, during which they moult several times, the larvae develop into pupae. These pupae no longer feed, but they continue to breathe during their periodic visits to the surface of the water. The pupal stage lasts only two or three days, during which time the insect is developing wings and the other characteristic organs of the adult, and then the adult splits the pupal skin and emerges from it; in a short time its wings become dry and hardened, and it flies away. As a rule the females become fertilized very soon after they emerge, and begin to lay their eggs shortly after their first blood meal.

Mosquitoes are small and delicate insects. They do not fly well against a wind, but they can travel several miles in still air, and farther down wind. The females which seek blood meals may, as stated above, prefer animal rather than human blood, or vice versa, but even those which under equal conditions would prefer human

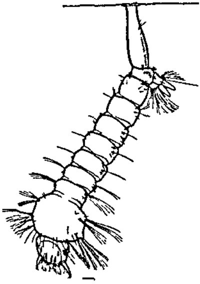


FIG 7 *Culex* larva Magnified 20 times
The larva lies at an angle to the surface of the water when breathing (*Aëdes* adopts a similar position)

blood may be side-tracked to animals if the latter are more conveniently situated for them. This fact has some value in the prevention of malaria; a collection of cattle sheds or pigsties situated between *Anopheles* breeding place and human habitations may attract the mosquitoes and obviate many human infections But some *Anopheles*, like the notorious *A. gambiae* of Central Africa, are avid for human blood and are not much deflected by animals

The following list of some of the important species of *Anopheles*

not interbreed, and that although each species can maintain itself against minor changes in its environment, there are limits beyond which it cannot survive. *The list is by no means complete.*

Some Species of Anopheles important in the transmission of Malaria

Species	*Breeding places*
EUROPE	
A. maculipennis atroparvus	Brackish water, marshes, lagoons.
A. sacharovi (*A. elutus*)	Marshes, fresh or brackish.
A. superpictus	Hill streams, flowing water in irrigation channels.
ASIA	
A. aconitus	Irrigation ditches, swamps, rice-fields, drains, pools.
A. culicifacies	Clean water, irrigation channels, pools in stream beds, borrow-pits, rice-fields
A. fluviatilis	Streams, springs, irrigation channels in hilly country.
A. leucosphyrus	Shaded pools and springs in jungle country.
A. maculatus	Streams, seepages, pools open to the sun.
A. minimus	Clear, sunlit, slow streams, and springs with grassy margins, irrigation ditches.
A. sundaicus	Brackish lagoons and swamps.
A. umbrosus	Shaded jungle pools and swamps.
AFRICA	
A. funestus	Grassy streams, seepages, and margins of lakes.
A. gambiae	Pools, puddles, animal hoofprints, ditches, seepages, barrels, tins, &c., open to the sun.
A. melas	Brackish mangrove swamps.
AMERICA	
A. albimanus	Fresh or brackish, sunlit, stagnant water of many kinds.
A. bellator	Collections of water at the leaf bases of bromeliads parasitic on various trees.
A. darlingi	Shaded, clear, freshwater lagoons, overflows, &c.
A. quadrimaculatus	Clear, exposed or partly shaded pools, lakes, swamps, slow rivers.

AUSTRALASIA AND THE PACIFIC

A. punctulatus	Small sunlit rain pools, edges of streams.
A. punctulatus farauti	Many kinds of water, fresh or brackish, clear or polluted.

Symptoms. An attack of malaria is similar in many respects to an attack of any fever. The normal body temperature is 98·4° F, and when the body temperature is raised above this the patient usually (but not always) feels ill; the skin is dry (except that from time to time heavy sweats may occur); the pulse is rapid, the urine

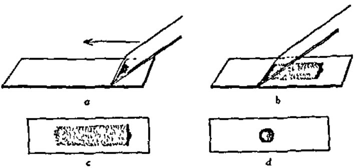


FIG 8 Preparation of blood slides

a (1) Place a drop of blood near one end of the slide, touch it with the edge of a second slide

b (2) Push the second slide along, dragging the blood behind it

c (3) Allow the blood to dry, it should be a thin film

d A thick drop (for a separate examination), in the centre of the slide Allow the blood to dry

is scanty and highly coloured; the patient is usually constipated (except in some of the intestinal diseases), headache and aching pains in the limbs and back are often present. These are symptoms common to most diseases in which the body temperature is raised, and it is usually difficult, or impossible, to make a correct diagnosis [illegible]

who is attacked by a fever when away from a doctor is very often correct in diagnosing it as malaria, and wise in treating it as such. Yet this is only a diagnosis on probabilities, and there have been many cases in which the true cause of the fever (sleeping sic

typhoid fever, and other diseases) has been missed for some time before starting to treat himself for malaria, should retire to his bed while the temperature is raised, and if the fever does not disappear after 4 or 5 days on full malaria treatment (see below), he should take immediate steps to get medical assistance. If there are other symptoms—rash, diarrhoea, &c.—another diagnosis is more probable

In the first attack of malaria the fever is usually continuous for the first few days; only at a later stage of the first attack, and during subsequent attacks, does the characteristic tertian or quartan periodicity of fever appear. This periodicity is related to the splitting of the mature malaria parasite into the 6–24 young forms which have been mentioned. When this splitting occurs, the red blood-cells in which the parasites are present are burst, the young parasites are set free into the blood, and enter other red blood-cells. It will be understood that this frequent destruction of red blood-cells by the parasites results in anaemia. During these paroxysms of fever three stages—cold, hot, and sweating—are usual. After the sweating stage the temperature falls until the next paroxysm occurs a day or so later.

In malaria the fever is usually accompanied by severe headache, and often by nausea and vomiting. There is no rash. Diagnosis is made with certainty only by the finding of malaria parasites in the blood. For this the blood must be dropped, or spread, on to a glass slide, stained, and examined by means of a microscope. This examination is a highly skilled procedure. The spleen may become enlarged at a later stage; in the indigenous peoples constantly subject to malaria the spleen may be enormous in childhood, and somewhat enlarged throughout life.

If malignant tertian malaria is not treated by one of the drugs now available (as is so often the case among the indigenous peoples of the tropics) it may kill the patient in a few days, or it may gradually disappear, after some weeks of fever and emaciation, and the patient may feel reasonably well. In this case it is probable that some parasites continue to live and multiply in his internal organs, and it is common for a recrudescence of the disease to occur, with the typical attack of fever, some weeks or months later, and again and again after that for a period of one year or more.

In untreated benign tertian malaria a fatal result is rare, and recovery usually takes place, but the disease tends to relapse weeks or months later, and again and again over a period of several years. Benign tertian malaria in one respect shows most beautifully that interlocking of different biological activities which is so impressive a feature in nature. In countries of the temperate zone in which the winter is cold (Holland, for instance), the *Anopheles* females hibernate during the cold weather, to become active again, and to seek blood meals, in spring. It is a common, but by no means invariable, feature of benign tertian malaria in those countries, that after an attack in autumn, no relapse occurs until spring, and it sometimes happens that a person actually infected in autumn shows no sign of the disease until the following spring, the incubation period in such cases being exceptionally long At the time, therefore, when the hibernating mosquitoes seek their blood meals in spring, the benign tertian parasites begin to multiply and appear in the blood of the human patients, and the sexual forms which can only develop in *Anopheles* are formed in the blood at the time when the mosquitoes begin to seek blood The two activities, of the parasite and of the mosquitoes, are synchronized, and the continuity of development of the parasite is thus ensured. The reason for this quiescence during winter, and relapse in spring, is not known, it is not a feature of the malignant tertian parasite, which flourishes only in warmer climates where hibernation of mosquitoes does not occur, and it is not a feature of quartan or *P ovale* malaria It would be misleading to say that nature deliberately designed the interlocking process, but one may note and admire the synchrony. It is certainly evidence that the biological characters of the parasites of disease tend strongly to promote their survival.

Plasmodium ovale malaria occasionally relapses, but dies out fairly soon. Quartan malaria also relapses, and may do so up to 10 years or more after the first attack, but it does not show the same predilection for relapse in spring, which is so characteristic of benign tertian malaria in some countries.

Treatment. The patient with malaria should be treated in bed, under a mosquito-net at night, so that he cannot be bitten by mosquitoes and infect them. His diet should be light, but it is important that he should take plenty of fluid; he will lose large quantities during his phases of sweating, and this fluid must be replaced.

The drugs most used for malaria are quinine, mepacrine (atebrin, quinacrine), paludrine, and chloroquine; sometimes pamaquin (plasmoquine) is also used.

Quinine is useful in cases where there may be danger, and in the early stages of any attack. In exceptionally severe cases of malignant tertian malaria, and in cerebral malaria, it may be necessary to inject quinine into a muscle or vein, but these procedures require expert skill.

The doses of the chief anti-malarial drugs are set out below:

ANTI-MALARIAL DRUGS

Dosage for adults

[Dosage for infants and children is reduced according to age. A rough rule is $\frac{\text{age}}{\text{age}+12}$. Thus for a child aged 4 the dose is $\frac{4}{4+12} = \frac{1}{4}$ the adult dose.]

QUININE bihydrochloride or bisulphate.

Curative: 20 grains each day (divided into several doses) for several days; when the fever has subsided, a course of mepacrine should be given (*see below*).

Suppressive. 10 grains each day (but mepacrine is more effective).

MEPACRINE (atebrin, quinacrine) dihydrochloride.

Curative: 0·2 gm. every 6 hours on the first day; then 0·1 gm. three times a day for 6 days. Total 2·8 gm. in 7 days. Infants up to 1 year

Curative: 1·0 gm. as initial dose, followed in 6 hours by 0·5 gm.; then 0·5 gm. once daily for 2 days. Total 2·5 gm. in 3 days.

Suppressive: 0·5 gm. once each week.

PALUDRINE (proguanil, chlorguanide) monohydrochloride.

Curative: *P. falciparum* infections 0·3 gm. twice daily for 10 days, reinforced on the first day of treatment with three doses each of 0·3 gm. mepacrine. Then 0·1 gm. paludrine daily for 6 weeks.

P. vivax infections. 0·1 gm. paludrine plus 0·01 gm. pamaquin, three times each day for 10 days. (The patient must be kept in bed

time); for children a proportionate dose should be given.

These are the bare outlines of treatment for Europeans and other non-immune peoples; the reader will understand that, as in all diseases, treatment is an individual matter which must be adapted to the patient, and that the adaptations are made as a [illegible]

commencing treatment if he suspects malaria, because if the treatment of malignant tertian malaria is delayed, the result may be disaster, and he usually cannot tell whether it is benign or malignant. But he should seek medical aid as soon as possible, and should always bear in mind that his diagnosis may be wrong.

The indigenous people of malarious countries are usually either partly or completely immune to the local strains of malaria parasites. If the immunity is not complete, they may suffer occasionally from attacks of the disease; it is a feature of such people that the attacks are quickly brought to an end by one or two moderate doses of quinine.

Prevention. Europeans who go to live in malarious countries should take precautions against infection; there are very few people who are naturally immune to malaria. It is a mistake to think that by drinking whisky, or any other form of alcohol, one may discourage mosquitoes from biting

Personal protection. Some or all of the following precautions should be taken, but since conditions with regard to malaria vary from place to place, and sometimes from season to season, the reader should take advice locally on these points.

At sundown long trousers and mosquito-boots, and garments with long sleeves, should be put on Mosquitoes bite after dusk, [illegible]

is obvious, and mosquito-boots are not very useful to women if they do not extend well above the knees Face cream containing dimethyl phthalate may be applied to exposed parts of the skin (but not near the eyes); this acts as a repellant to biting insects, but it is effective for only a few hours, and tends to be rubbed off, or to be washed away by sweat *Europeans should sleep under mosquito-nets,* which should be properly applied to the special

bed-posts. The net should be fixed *inside* the posts, and tucked under the mattress; there should be no folding flaps to the net, which should be complete in one piece.

The windows and doors of the houses are often covered with metal mosquito-gauze. If this is done it should be done completely,

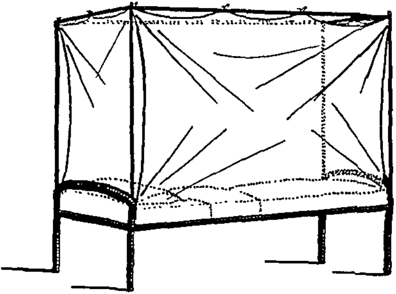


Fig 9 Bed, with mosquito-net tied inside the frame and tucked under the mattress.

otherwise the house or room will admit mosquitoes through unprotected openings, and *will retain them. Mosquito-proofed doors* must be so made that they open outwards; if they open inwards any mosquitoes resting on them are likely to be introduced into the house when the door is opened. *It is important to make sure* that no openings round the ceiling are left uncovered by mosquito-gauze.

Houses should be built away *from* mosquito *breeding places* (streams especially should be avoided), or such breeding places [illegible] is that *if there is no breeding*

from the direction of the breeding place. No doubt a greater pro-

tection would be afforded by eradication of breeding within ¾ or 1 mile.

Householders should be careful that mosquito breeding does not take place in domestic collections of water, such as in barrels, old tins, boxes, roof gutters, flower vases, water closet cisterns, and tins of water into which the legs of meat safes are sometimes placed to trap ants. Such collections can be very dangerous, but the risk can be avoided by abolishing gutters and collections of rubbish, by regular emptying of vases, &c., once at least each week, and by using covers, or gauze, for barrels and cisterns. Ant traps should either be abolished, or the water in them should be emptied or covered with oil regularly once each week.

Suppressive drugs may be taken. During the 1939–45 war it was found that quinine (5–10 grains) taken regularly every day had some value in preventing attacks of malaria, but not much. Mepacrine (0·1 gramme each day), however, was extremely effective; in this dose it gives a yellow tint to the skin, but prevents fever, and if continued for a month after leaving the malarious area it will usually completely eliminate malignant tertian malaria. Benign tertian malaria, however, may occur after the mepacrine has been discontinued. Paludrine in doses of 0·3 gramme once each week is also successful in preventing attacks in some countries, but it is usually necessary to give 0·1 gramme each day. Chloroquine is given in a dose of 0·5 gramme once each week, but this dosage may need modification in the light of further experience.

Administration of these drugs for prevention of malaria should be started two weeks before entering a highly malarious area, and continued for four weeks after leaving it.

It has never hitherto been found possible to eradicate malaria in [illegible] all members of a community receive treatment.

General control. This is a big subject because, although means of preventing the breeding of *Anopheles* are well known, the mere fact that so many countless millions breed in so many small or large collections of water, makes effective control a matter of the greatest difficulty.

Collections of water may be dealt with by filling them in, or by

draining them; they may be covered at intervals of one week or so by a film of oil, which suffocates or poisons the mosquito larvae. Certain oils are better than others, and various mixtures are used according to local conditions, for which expert advice should be sought. In the absence of expert knowledge, kerosene may be used, either alone, or mixed with waste motor oil (in proportion of about 3 to 1), but kerosene is expensive.

To the oil may be added DDT (dichlor-diphenyl-trichlor-ethane) the well-known insecticide, in a proportion of 5–10 per cent.; this poisons the larvae. Larvae may also be poisoned by paris green (a preparation of arsenic) This, like DDT, should be used only under expert advice, since injudicious use may be harmful to cattle or man, if the water is used for drinking.

Streams may be protected by clearing grass or other vegetation from the banks, making them sharp and clear-cut, so that eddies and small back-waters are eliminated; larvae do not thrive in flowing water, but do thrive in back-waters of streams. Shade trees may either be cut down if the larvae concerned thrive in shade, or they may be encouraged and planted if the larvae prefer water open to sunlight. It is, however, necessary to be careful. Removal of *trees from the banks of a stream may help to eliminate one species* of *Anopheles*, but may create conditions favourable for another, perhaps more dangerous, species, as has happened in Malaya.

Streams may be flushed at intervals with a torrent of water which will sweep larvae away. This is done in many countries, and various devices have been invented, most of which involve dams, whereby it is done automatically. Streams may be covered with oil, and again, for this, automatic apparatus has been devised.

All these measures have their own applications, but before they are started, expert advice should be sought; steps taken without adequate knowledge of local conditions and species *may easily* make matters worse.

On the other hand, small collections of water like road puddles, water in hoof marks, car ruts, and other similar depressions which fill during the rainy season, are such common sources of *Anopheles* [illegible]

be sought out and drained. Drains themselves, if open, may be immense sources of danger if they are not kept clean. Water may

collect and stand in them as a result of small obstructions to flow, and their sides may be broken by cattle or man, creating pools which permit breeding. Drains should therefore be constantly [illegible]

[illegible] coastal salt mangrove swamps are very great, yet such swamps form breeding places for several dangerous species of *Anopheles*.

The new insecticides, DDT, benzene hexachloride, and the older ones whose basis is pyrethrum, are now being used for killing adult mosquitoes much more widely and successfully than ever before, they are extremely valuable, and their use was in part, at least, responsible for the fact that the malaria problem in the 1939–45 war was very largely reduced. A solution of DDT in kerosene, or a suspension in water, each of 5 per cent strength, is used to spray walls and ceilings of houses. When the kerosene or water evaporates, the minute crystals of DDT are left adhering to the walls. DDT is intensely poisonous to mosquitoes and other insects, and penetrates the cuticle of their feet and other parts, so that a mosquito which alights on a wall which has been sprayed with DDT, and whose feet come into contact with a crystal, is killed in a relatively short time. Moreover, DDT does not repel most mosquitoes, it does not deter them from alighting. Many mosquitoes rest on walls inside houses during the night, before or after feeding, and these mosquitoes, therefore, can be attacked in this way. The DDT can be applied to a bed-net, towards which mosquitoes are [illegible]

[illegible] is somewhat similar. The pyrethrum preparations are quickly lethal to mosquitoes, but they do not persist. The one great virtue of DDT is that a wall which has been sprayed retains its power of killing insects for days or weeks, the length of time depending on several factors, composition of the wall surface, humidity, &c.

In general it may be said that for personal protection DDT is exceedingly important; houses sprayed regularly each week, or even less often, will be much more free from mosquitoes and flies than those not sprayed. DDT should be used, therefore, but on the understanding that it is not an infallible protection.

The control of malaria in the indigenous peoples of tropical

countries is a complicated problem. If control is not complete, the people may lose some immunity and still suffer severely from the disease; moreover, in villages and even in towns, control is rarely complete. On plantations and industrial compounds, on the other hand, an energetic manager can usually suppress *Anopheles* breeding if he will, can so site his labourers' houses that they are not within ½-mile of breeding places, and can, indeed, carry out most of the usual anti-malaria measures. If this is done, the health of the labourers is correspondingly improved On many estates the labourers are recruited from areas in which malaria is not particularly prevalent, and the men have little immunity; they therefore suffer severely if sent to work in a highly malarious environment. The writer believes that it is a duty of estate owners to ensure that on their estates malaria is reduced by all means in their power, and that it is part of the duty of administrative officers to ensure that steps are taken to protect the labourers, by asking the assistance of the medical department or by making representation to Government in those cases in which this duty is neglected. Sometimes the managers of estates can be induced to adopt anti-malaria measures because the improvement in general health of the labourers is a financial gain—they work better and are not absent from work so often as a result of sickness. This argument can, of course, be used, but the administrative officer is concerned with the welfare of the labourer as a human being, not merely as a unit of production, and he should insist on good conditions whether they increase profits or not.

Blackwater Fever

Blackwater fever is related to malaria in that it occurs only in people who, at some time, have suffered from malignant tertian malaria (though there is some evidence that, occasionally, it may take its origin from benign tertian malaria). It is a comparatively uncommon disease, but it is more common in persons relatively non-immune to malaria than in those relatively immune—in Europeans than in Africans. It does not necessarily occur during an actual attack of malaria. The cause of blackwater fever is not clearly known—obviously, every person who has had malignant tertian malaria does not get blackwater fever, and although there is good evidence that exposure to cold and excessive fatigue may precipitate the disease, there are many cases in which this does not

happen. The actual process which produces the characteristic dark urine is still debated.

Symptoms. This is a very acute disease. The patient is feverish, and the urine suddenly becomes the colour of stout, almost black. This is the result of a sudden, massive destruction of the red corpuscles of the blood, and the black colour is due to the excretion by the kidneys of the pigment (haemoglobin) normally contained in the red cells, and now altered in the process of excretion so that its colour is darkened. It is still not certainly known what precipitates this sudden destruction of cells. The patient is gravely ill and becomes progressively more anaemic as more of the cells are destroyed. The kidneys may be severely affected, and in grave cases may cease to secrete urine In this case the patient usually dies. In non-fatal cases the fever begins to abate after a few days, the urine gradually becomes normal, and the patient feels better, but is extremely weak and anaemic A patient who has once had blackwater fever should seriously consider a very radical change in his mode of life, even to leaving the tropics permanently

Treatment. If possible, the patient should not be moved, but should be treated where he is. This is not always possible, of course, but he should not be moved more than is absolutely necessary. He should be in bed He will need plenty of fluid by the mouth, but little or no food during the height of the fever He may need transfusion of blood of the correct blood group, or infusions of salt solution into a vein, or injections of drugs to help the action of the heart. All these are skilled procedures only to be carried out under direct medical supervision.

Prevention. Precautions should be taken against malaria, and exposure, exhaustion, and excesses should be avoided There is some evidence that the taking of a moderate dose of quinine by a person subject to malignant tertian malaria, when he feels an attack coming on, may precipitate an attack of blackwater fever It is wiser to take small doses at first, with plenty of fluid, or to take mepacrine. During the 1939-45 war it was noted that blackwater fever was rare among the troops who had been taking mepacrine regularly to suppress malaria.

CHAPTER IV

PROTOZOAL DISEASES: INSECT-BORNE *(cont.)*

Trypanosomiasis (Sleeping Sickness)

TRYPANOSOMIASIS is found throughout tropical Africa; it has been responsible for serious epidemics, and demands continuous effort for its control. A similar disease affects domestic and wild animals in Africa, and animals are probably, to a small extent, the reservoir of the human disease. In South and Central America there is a form of human trypanosomiasis, but it differs widely from the African form, and will not be described in detail here.

Cause. Human trypanosomiasis is caused by a protozoon (called a trypanosome) which infects the blood or tissues of man Two species are recognized, *Trypanosoma rhodesiense* and *T. gambiense.* The former is found chiefly in East Africa and the Rhodesias, the latter in West and Central Africa, and also in the Sudan and Uganda. These trypanosomes are actively *motile,* and *multiply in man by* simple division. If they are present in blood taken up by certain tsetse *flies when they bite, they undergo* a cycle of development in the flies, and after a week or more make their way to the salivary glands of the flies, to be injected into the next animal or man upon which the flies feed.

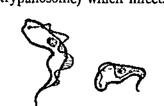
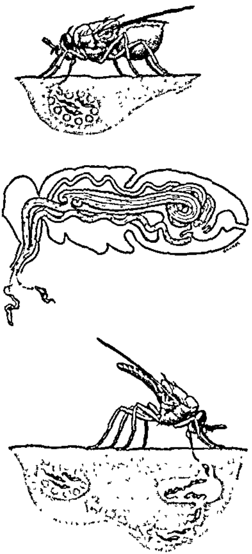


FIG 10 Trypanosomes in human blood Magnified 1,000 times

Transmission. Although it is possible that trypanosomes can be transferred directly from one person to another if a tsetse fly bites an infected person and then within a few minutes bites a second, uninfected, person, transferring trypanosomes which are still alive on its soiled proboscis, the usual method by which trypanosomes are transferred is as described above, by injection after they have undergone a period of cyclical development. Both male and female tsetse take blood meals, and both transmit trypanosomiasis. Several species of tsetse *fly are capable of* promoting this cyclical development, but no other kind of biting



The tsetse fly (male or female) takes up the blood of the sick person, which contains trypanosomes

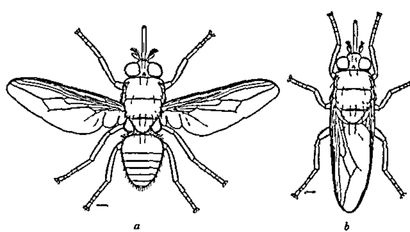
The trypanosomes enter the gut of the tsetse fly, and there they develop and increase in numbers by a process of division. The trypanosomes travel along the gut to the end of a lining membrane, and then they double back between it and the gut wall passing into the proboscis and from there into the salivary glands

From the salivary glands the trypanosomes are injected into animals (or man) at subsequent feeds. The whole cycle in the tsetse fly occupies about 20 days.

FIG 11. The trypanosomiasis cycle.

Diagrammatic The sizes of the parasites and tsetse flies are not in proportion to each other.

fly is capable of doing so. This probably explains the fact that although, in the days of slavery, infected Africans were undoubtedly introduced in large numbers into the Americas, the African disease has never spread there because there are no tsetse flies. This state



a *b*

FIG. 12 Tsetse fly. Magnified 4 times
The natural colour is dark grey-brown.

a *With wings extended, showing the veins on the wings* forming the typical 'hatchet' shape.

b In the natural resting position with folded wings

of affairs may be changed if living tsetse are introduced into America inadvertently by aircraft, and multiply there, as is quite possible unless careful precautions are taken to prevent it.

The species of tsetse most closely involved in transmission of trypanosomiasis are *Glossina morsitans* and *G. swynnertoni* (largely but not entirely associated with the East African *Trypanosoma rhodesiense*), and *G. palpalis* and *G. tachinoides* (associated with *T. gambiense*). These flies differ in their climatic preferences: *G. morsitans* and *G. swynnertoni* live in savannah country with scattered woodland; *G. palpalis* and *G. tachinoides* are found in the vegetation along rivers and lakes, or, exceptionally, in fairly thick forest where humidity is high. *G. morsitans* and *G. swynnertoni* feed principally on game, especially on antelopes; *G. palpalis* and *G. tachinoides* feed on domestic and game animals, but also on lizards and crocodiles; all these flies attack man readily, and are

essentially day-biting flies. They do not seek human habitations, but bite in the open.

Female tsetse flies produce larvae singly, depositing them on the ground, usually in shaded places; the larvae change almost at once into pupae, and develop into adult flies after 3–4 weeks. Adult flies usually do not live more than 3 months, and one female produces

less than 5 per cent.

Symptoms. Sleeping sickness (trypanosomiasis) should not be confused with 'sleepy sickness' (encephalitis lethargica) which is due to a virus, is not transmitted by tsetse, and occurs throughout the world. Sleeping sickness due to *T. rhodesiense* is usually relatively acute. It begins with fever which may be confused with malaria, and if it is not treated it progresses, leading to emaciation and death in a few months; spontaneous recovery is very rare. Sleeping sickness due to *T. gambiense* may be similar, but more usually it assumes a slow, chronic form, with occasional fever, and enlargement of the lymphatic glands of the neck and elsewhere, and eventually passes to the stage when the patient sleeps most of the time, is emaciated, and finally dies. In the *rhodesiense* form, diagnosis is usually made quite easily by microscopic examination

obtained from the enlarged glands. In both forms the trypanosomes eventually invade the central nervous system, unless proper treatment is given, and when this has occurred, recovery is rare.

Treatment is extremely successful, provided it is given in the early stages of the disease. It consists of intravenous injections of Antrypol (Germanin, Bayer 205, Moranyl) and tryparsamide, but recently some success has also attended the use of propamidine and pentamidine. Intravenous injection is a skilled procedure, and if badly done may cause considerable destruction of tissue round the needle track, or even death if air is permitted to enter the vein. If an administrative officer sees cases of trypanosomiasis, therefore, he should arrange for some person accustomed to giving

intravenous injections to attend them. In West Africa many African dispensers have been taught the technique.

Prevention. One method of control which has achieved considerable, though only partial, success is treatment of the sick, on a big scale. The injection of the drugs mentioned above may not cure advanced cases or kill the trypanosomes in the central nervous system, but it is usually effective in killing those that are present in the blood; the result is that treated persons become incapable, for some time, of infecting tsetse flies which bite them, though in advanced cases the blood again becomes positive after some weeks, unless further injections are given. Moreover, in early cases, treatment is very effective, and cure is usually permanent unless the patient becomes reinfected. In West Africa, therefore, teams are sent out among the people, to diagnose and treat all cases of trypanosomiasis. By this means the incidence may be reduced to one-tenth of the original figure, but it is doubtful if the disease has ever been completely eradicated from any district by treatment alone. Nevertheless, it is a useful measure of control and, of course, should be undertaken in the interest of the individual patients.

It seems probable that the only means of complete eradication

a cause of enormous loss of stock. The trypanosomes responsible for most of the disease in stock are not the same as those which cause human disease, but they are spread by tsetse.) To eradicate tsetse from the vicinity of man is a very large undertaking, which needs close study of the habits of the flies. Those which haunt the vegetation along rivers or lake shores can be dealt with by clearing away this vegetation, either wholly or in part, according to its nature and its attractiveness to the flies. Clearing must usually be continued for some distance, since flies will cross considerable stretches of open ground or open water. Clearings, when once made, require constant supervision to prevent regrowth, and the amount of labour needed is considerable. In West Africa, where the dangerous flies haunt the rivers, trypanosomiasis has been associated with alluvial gold-fields. It would seem to be the undoubted responsibility of the employers to take all possible steps to eliminate this hazard. For flies which live away from water, in wooded savannah country, clearing of certain types of vegetation,

creation of barrier thicket, control of annual grass-burning, trapping, and the killing of game are all employed. The last has been used because these flies (*G. morsitans*, *G. swynnertoni*, and *G. pallidipes*) are essentially game flies, reduction of the animals reduces the food of the flies, and they therefore tend to die out Considerable success has attended this method in the Rhodesias, where scores of thousands of game animals have been shot. Though this is not a method to be used if others could be as successful, it seems that there are circumstances in which destruction of game is the only practicable measure yet possible for the protection of man and his domestic animals.

There are, throughout Africa, tracts of country free, or almost free, from the kinds of woodland which attract tsetse flies, and in which the flies cannot live A relatively small amount of labour suffices to render these regions suitable for human settlement, and in both East and West Africa such settlements have been made, and whole populations have been moved from tsetse-infested to tsetse-free country, with great benefit. The most outstanding example is the Anchau Corridor, of 700 square miles, in Nigeria, which has been a great success In such transfer of whole populations many sociological problems arise which are best dealt with by administrative officers, and, in fact, the success of these most essential ventures depends upon co-operation between all the departments concerned, medical, veterinary, agricultural, forestry, survey, educational, and administrative. Properly controlled, such settlements may become models, in which the general health of the inhabitants, and their social and economic welfare, may be enormously improved. Badly controlled, they may fail and discourage further effort.

The new insecticides are effective against tsetse flies; the difficulty is to devise some means by which the relatively few, and widely scattered, flies can be brought into contact with them. Research on the subject is being actively pursued

Leishmaniasis

Leishmaniasis is seen in three forms. *kala azar*, the general disease, found in China, India, Africa, southern Europe, South America; *oriental sore*, a skin sore, found in India, the Middle East, Africa; *espundia*, the muco-cutaneous form, found chiefly in South America, but also in the Sudan.

Cause. The three forms of leishmaniasis are caused by protozoa of the genus *Leishmania*, so named after Sir William Leishman who discovered them. Three species are recognized, *L. donovani*, *L. tropica*, and *L. braziliensis*, which cause kala azar, oriental sore, and espundia respectively. These minute protozoa live in certain cells of the blood, skin, mucous membranes, or internal organs; they multiply by division, like the trypanosomes, and are transmitted by sand-flies. Dogs and some other animals suffer from these diseases, and the sand-flies convey the infection either from man to man or from animal to man In the sand-flies the leishmaniae develop in a form somewhat different from that seen in human tissues

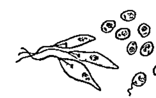
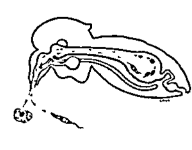


FIG 13 *Leishmania* (round forms) as seen in human tissues, and (elongated forms) as seen in sand-flies Magnified 2,000 times

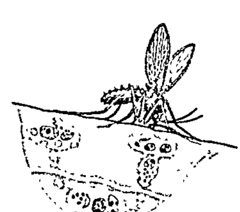
Transmission. Sand-flies (genus *Phlebotomus*) are very small, delicate insects; both sexes suck blood. The females lay their eggs in rubble, broken masonry, cracks in earth floors or sand; the larvae which emerge feed on organic matter, and some moisture is necessary for them. The larval period varies, it may last up to 4 weeks, or even longer. These small flies bite chiefly at night. They can pass through an ordinary mosquito-net, and in countries where the diseases (including sand-fly fever) conveyed by them are prevalent, it may be necessary to use sand-fly bed-nets, in which the meshes are very small. Sand-flies usually remain near the ground, and it is said that they do not usually attack people who sleep one story above ground.

Symptoms. *Kala azar* is a slow disease, characterized by fever, gradually progressive anaemia, enlargement of the spleen and liver, and emaciation. If it is not treated it is fatal in about 90 per cent. of cases, after an illness lasting months or years, though it is sometimes acute. The name kala azar means black disease, and sometimes a peculiar earthy tint is observed in the skin. *Oriental sore* (which has received a multitude of local names, Delhi boil, Aleppo boil, Bouton de Bagdad, &c.) is a chronic sore which forms and develops slowly on the exposed parts of the skin—face, arms, legs. If it is not treated it tends, after many months, to spontaneous cure, and the patient is thereafter in a state of immunity. *Espundia* is

The sand fly takes up the leish-
maniae (round forms) when it
bites a patient (or dog) suffering
from leishmaniasis



The leishmaniae develop and
increase in numbers by a process
of division in the stomach of the
sand-fly. They become elon-
gated and move forward to the
pharynx and there multiply so
greatly that they block the pas-
sage



The sand fly injects the elon-
gated flagellate forms into man
(or dogs) when it subsequently
attempts to feed. The whole
cycle in the sand fly occupies
about 10 days

FIG. 14. The leishmaniasis cycle
Diagrammatic. The sizes of the parasites and sand-flies are not in proportion to
each other

characterized by chronic ulceration of the nasal or oral mucous membrane, and the adjoining skin; these ulcers cause extensive destruction of tissue, and the disease, if not treated, is often fatal.

In oriental sore and espundia the leishmaniae may be found in the tissues round the sores. Their recognition in microscopical preparations is not easy, they are very minute, and an inexperienced observer may easily miss them.

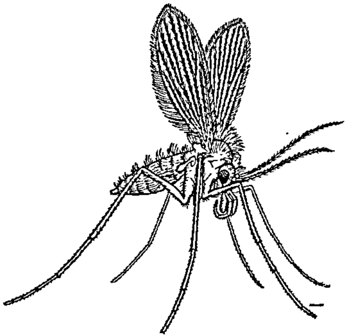


FIG 15 Sand-fly (*Phlebotomus*) Magnified 20 times.

The diagnosis of kala azar may be difficult, since the combination of fever, enlargement of the spleen, and anaemia, is found also in malaria, and both are chronic diseases. In a country in which both diseases exist, therefore, it would be unwise for the non-medical person to be over-confident of his own diagnosis, either in relation to his own family or to the inhabitants of the area.

Treatment. Kala azar in India is usually treated with success by injections of certain preparations of antimony, but in the Sudan the disease is more difficult to cure. Alternative treatment with stilbamidine, propamidine, or pentamidine, which have been intro-

duced in recent years, may be desirable. All these drugs are dangerous unless given with discretion, and all involve intravenous or intramuscular injection; the frequency of injection, dose, and duration of treatment depend so much upon the individual patient that only persons trained in the technique should attempt to give the treatment.

Similar drugs are injected for oriental sore and espundia, but espundia is difficult to cure. Oriental sore is also successfully treated by injections of mepacrine, or other substances, round the base of the sore, but this again requires skill and training if it is to be successful

Prevention. Kala azar sometimes affects only a few members of a community, and in these circumstances there seems to be little more to do than to treat such persons as develop the disease Sometimes, however, it becomes epidemic, and a relatively large proportion of the population are affected, and there are many deaths In such circumstances it is necessary to take other steps, so that further spread may be checked. One method used successfully in the past in India was to remove the whole village to a new site a few miles away By this means the people were taken away from the infected sand-flies But this procedure is not usually possible and other methods must be used General cleanliness and tidiness of houses and compounds, removal of organic refuse and of rubbish heaps, and the use of DDT on the ground around the houses, have great effect in reducing the breeding of sand-flies

In Crete and other Mediterranean countries it is known that dogs suffer from kala azar and that infection can be conveyed from them to man by sand-flies The Greek government, therefore, have made certain regulations relating to inspection and control of dogs, which have undoubted value in the prevention of human disease.

For oriental sore a vaccine has been prepared. If this is injected it produces a small sore, which gradually develops and then heals The patient is then, apparently, immune to natural infections The chief point about this process is that the sore due to the inoculation can be induced on the leg or arm at will, natural sores may arise on the face, giving great and permanent disfigurement which can be avoided by inoculation The subject is, however, still in the experimental stage.

CHAPTER V

VIRUS DISEASES: INSECT-BORNE

Yellow Fever

Distribution. Yellow fever is found in Africa, from the Sudan a Abyssinia, part of Uganda, Kenya, and N. Rhodesia, to the Belgi Congo, French, British, and Spanish West Africa; it is also fou over large areas of South America.

Cause. Yellow fever is caused by one of the smallest of t viruses, quite invisible through any ordinary microscope. Li other viruses, it cannot be cultivated on artificial culture med but can be propagated in living tissue cultures and in the develo ing embryos of fertilized hens' eggs. Viruses cannot grow exce in association with living cells, but they are, presumably, ther selves living particles, and, presumably, propagate by division ar growth, but the processes are not known.

Transmission. Yellow fever is a disease of man, and is tran mitted from man to man by mosquitoes; it is also a disease monkeys, and is transmitted from monkey to monkey, and fro monkey to man, by mosquitoes; but the *mosquitoes are not th* same in the two forms of the disease. So far as is known, the viru of the human disease is identical with the virus of the monke disease; the only difference is in the circumstances in which th diseases are contracted.

The purely human disease is known as *urban yellow fever* becaus it has so often been a disease of cities or towns (Havana, Rio d Janeiro), but the same disease, carried by the same mosquitoes occurs in village communities. This form is conveyed from man to man by a number of mosquitoes, most of which are the genu *Aëdes*, and the most important of which is *Aëdes aegypti*. These mosquitoes feed on man, often in the day-time, and if the person whose blood they suck is in the first few days of an attack of yellow fever, when the virus particles are present in his blood, the mos- quitoes become infected. The virus develops in some unknown way in the mosquito, and after about one week it is present in the saliva of the mosquito, and may therefore be transmitted to a second person when the mosquito feeds again. Female mosquitoes

only are concerned in transmission; they are themselves, apparently, unharmed by the virus *Aëdes aegypti* is a black-and-white [illegible]

[illegible]

known as the tiger mosquito from its markings, and as the cistern

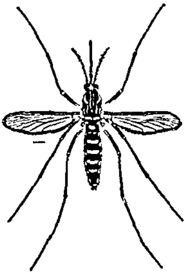


FIG 16 *Aëdes aegypti* mosquito (female) Magnified 7 times

Note the characteristic markings of body and legs, the short palps flanking the proboscis, and the antennae bearing a few hairs.

This mosquito carries yellow fever and dengue.

mosquito because of its preference for laying its eggs in cisterns and water butts, in water collected in roof gutters, vases, empty tins and bottles, and other small articles It does not breed in streams, ponds, or marshes, but in water even more closely associated with man.

The monkey disease is known as *jungle yellow fever*, and is spread among jungle monkeys in South America (and in East and West Africa) by mosquitoes which not only breed in jungle country away from the usual haunts of man, but which spend their lives

among the higher branches of the trees, where the monkeys also spend most of their time. In South America the red howler monkeys are involved, and the most important mosquito is *Haemogogus capricorni*, though there are others. Man becomes infected by accident while he is in the jungle country; the mosquitoes attack man readily enough if he comes their way, but they do not breed round his habitations. If a man contracts jungle yellow fever in this way, and returns to his village or town during the period before symptoms appear, and if during the first few days of his illness he is bitten by *Aëdes aegypti* mosquitoes breeding near his home, he may infect them, and they may in due course infect other people in the town or village. In this way a typical epidemic of urban yellow fever may arise from a single attack of jungle yellow fever, for the virus is the same.

The yellow fever virus is present in the blood of a patient probably just before symptoms commence, and for 2 or 3 days after the onset of fever; after that the virus cannot be detected in the blood. A patient, therefore, can infect mosquitoes in the early part of the disease, but not later.

Symptoms. Yellow fever is one more of the numerous fevers of the tropics. The fever is acute in onset, and begins within 6 days of the bite of an infected mosquito. The temperature rises quickly and in a case of average severity the patient feels very ill, with intense headache, backache, and congestion of the eyes. Usually, but not always, the temperature begins to fall within a day or two of the initial rise, and the patient feels rather better; this is known as the period of calm. By the third day the yellow tinge (jaundice) from which the disease takes its name appears in the skin, gradually becoming pronounced. (The reader will understand that jaundice cannot be detected in a black skin, but can be observed on examination of the white of the eye.) Jaundice is due to the destructive action of the virus on the cells of the liver. In severe cases the fever increases again after 2 or 3 days of the period of calm, the jaundice deepens, and haemorrhages may occur beneath the skin or into the stomach, in which case the patient may vomit blood (usually dark brown, like coffee-grounds), or pass black, tarry motions. The urine is usually heavily laden with albumin.

The case-mortality rate varies in different epidemics, a rate as high as 80 per cent. has been recorded, and shocking epidemics have been described in troops in the West Indies during the

Napoleonic wars, and in West Africa. The first attempts to construct the Panama Canal were largely frustrated by yellow fever Epidemics of average severity may cause the death of 25–30 per cent. of those attacked, but in the most recent great epidemic, in the Nuba mountains of the Sudan in 1940, there were some 16,000 cases, of which about 10 per cent. were fatal. In general, the disease is less serious in children than in adults, and is probably less severe in populations indigenous to the countries in which it occurs, than in immigrants, such as Europeans and North Americans, to those countries It is, moreover, almost certain that many cases of mild yellow fever, so mild that jaundice does not appear, occur in South America and West Africa, and especially in children These are not diagnosed at the time, and the patients recover, examination of their blood afterwards, by a special test, reveals the fact that they have had the disease. After recovery from yellow fever, the patient is immune for life.

Treatment. There is no specific treatment, all that can be done for the patient is to conserve his strength by good nursing. It is of the greatest importance that he should be nursed, night and day, inside an efficient mosquito-net so that there may be no danger of mosquitoes becoming infected from him, to carry the disease to other people.

Prevention. When in 1900 the American Yellow Fever Commission in Cuba demonstrated by their classical research, in which they deliberately infected themselves, and in which some of them died, that yellow fever was transmitted by *Aëdes aegypti*, steps were taken to control the disease in Havana (where it was rife) and in the zone of operations for the Panama canal, by ruthless eradication of all possible breeding places of *Aëdes aegypti* These measures were highly successful, they entailed scrupulous control of even the smallest collections of water, and they were reinforced, in the canal zone, by screening the houses to prevent entry of mosquitoes (malaria, of course, was also a serious problem) At the present time attempts are made to prevent the breeding of *Aëdes aegypti* in many of the cities of yellow-fever countries, in Rio de Janeiro, for instance, a special permanent section of the public health department regularly inspects all premises and all open spaces, removing tins, bottles, and other vessels in which water may collect. One of the best means of eliminating *Aëdes aegypti* is to instal into a town a piped water supply, which will obviate the need for water butts and

other similar domestic collections. Moreover, the Brazilian Government and the Rockefeller Foundation have declared their aim of eliminating this mosquito completely from the whole valley of the Amazon.

In recent years, however, an effective vaccine has been prepared against yellow fever, and this gives very good protection for about 4 years after injection. The vaccine consists of living, but non-virulent, yellow fever virus, which has been cultivated in the embryo of hens' eggs. Standard doses are prepared, dried and frozen; they are tested before dispatch, and are kept frozen until the moment of injection, when they are reconstituted with water. In the dry and frozen state the virus remains alive for long periods, if warm or damp it soon dies. The vaccine most commonly used in South America and Africa, known as strain 17D and very famous, is derived from yellow fever virus obtained from a West African named Asibi, who, in 1927, had an attack of yellow fever, from which he recovered. In 1944 Asibi was found in his village, living in ill-health and poor. The Government officers, with happy thought, explained to him and to his friends that from the specimen of blood taken from him in 1927 had been developed the means for saving untold numbers of lives from yellow fever, and they gave him a pension.

In the early days of yellow-fever vaccination the vaccine virus was mixed with human serum before injection, but after a time it was seen that many of the persons inoculated with the vaccine developed jaundice (not yellow fever) some weeks later. Investigation indicated that this jaundice was due to some agent, probably another virus, present in a proportion of the samples of the human serum used in the preparation of the vaccine; the serum was therefore omitted (as it was found not to be essential) and the vaccine no longer gives rise to jaundice. This form of jaundice was usually mild, though occasionally it did even cause death.

It has been explained that yellow fever occurs in South America and in Africa as far east as the Sudan, and perhaps farther; it has never been recorded in India and the Far East. The mosquito *Aëdes aegypti*, however, exists and flourishes throughout tropical and sub-tropical Asia, especially along the coast lines. If yellow fever were introduced into India and these other countries, in which the people, having never experienced the disease, have acquired no immunity to it, there is little doubt that a devastating

epidemic would sweep through the countries before vaccination of the population could be carried out. Moreover, the reader will realize that to prevent the breeding of *Aëdes aegypti* in the crowded cities and villages of India, Malaya, the Netherlands East Indies, and Indo-China would be an enormous task, and that since at present that mosquito is of little or no public health importance in those countries, medical effort is much more wisely expended in other directions Nevertheless, there is a danger that yellow fever may be introduced by aircraft, either by the entry of a person in the incubation period of the disease (those few days between infec- [illegible]

aerodrome in Africa, and which may leave it on an aerodrome in India or elsewhere, to bite and infect one of the local inhabitants (Introduction of patients or infected mosquitoes on ships is most unlikely; for one thing, the incubation period is usually shorter than the voyage, and the passenger would be ill on arrival and would therefore be detained.) To prevent spread of yellow fever in this way by aircraft, the various countries of the world have agreed to certain Sanitary Conventions in which are laid down the regulations governing the maintenance of aerodromes free from mosquitoes, the laws requiring vaccination of all persons travelling from a yellow fever country to a non-yellow-fever country which might become infected, and the proper disinsectization of aircraft, to kill any mosquitoes which may have entered The details of these Conventions are too complicated to be quoted here, it is enough to know that they exist and to appreciate the reason for them. That the introduction of disease by aircraft is possible is indicated by the fact that living mosquitoes from Africa have been found in aircraft landing in Brazil.

Dengue

Distribution. Dengue, a mild fever with a negligible death-rate, is found in most countries in the tropics, and also in subtropical or even temperate zones Some years ago, for instance, there was a widespread epidemic in Greece.

Cause. Dengue is due to a virus, about which little can be said except that it does not confer lasting immunity on those who have had the disease.

Transmission. Dengue is transmitted from man to man b *Aëdes aegypti*, the same mosquito which is so closely involved i the spread of yellow fever; dengue may therefore occur in countrie in which this mosquito breeds. In the Pacific Islands *Aëdes albo pictus* is also involved.

Symptoms. In the classical attack there are three stages. Afte an incubation period of 5–9 days the temperature rises quickly, an headache, with severe aching pains in back and limbs, is a marke symptom. After 3 or 4 days the temperature falls, and the secon stage, of remission, occurs. The patient feels much better, but 2 o 3 days later the temperature rises again and the patient breaks int the characteristic dusky red rash. After this, recovery is rapid. Th disease, though not serious, is painful, and temporarily disables th patient. The saddle-back temperature and the remission of symp toms bear some likeness to the course of yellow fever, but i dengue jaundice is not a feature, the patient is not so ill, and th rash is characteristic.

Treatment. There is no specific treatment; all that can usefull be done is to make the patient as comfortable as possible by goo nursing

Prevention. The use of a mosquito-net, and the prevention o breeding of *Aëdes aegypti*, as for yellow fever, are applicable t dengue A vaccine has been tried, but is not of much practical use.

Sand-fly Fever

Distribution. This mild fever is found in countries where sand-flies (*Phlebotomus*) breed; it is especially common in the Middle East.

Cause. It is due to a virus akin to that of dengue.

Transmission *is by sand-flies, the same as those which transmit* leishmaniasis, especially *Phlebotomus papatasi.* The habits of these sand-flies have already been described.

Symptoms. These are not unlike those of dengue, except that pain is not so intense, and there is no distinctive rash. The patient feels very *ill for a few days but recovers very quickly; he* has no effective immunity against subsequent infections. This disease has been known to attack military units camping in sand-fly country, and to incapacitate large numbers of men at a time, for a few days. These trivial diseases may, in the first few days, be mistaken for graver fevers, or vice versa.

Treatment. There is no specific treatment.

Prevention. No vaccine is of practical use; precautions against sand-flies are mentioned under the section on leishmaniasis (p. 43). In Iraq, where at one time sand-fly fever was very troublesome to the R.A.F. contingents, Whittingham devised an effective method [illegible] strong enough to keep these feeble little flies away from the sleeping men.

Encephalitis

Distribution. Various forms of encephalitis are known, which are transmitted by mosquitoes or ticks. These occur in Japan, the U.S.S.R., South America, the West Indies, the United States, and Canada.

Cause. These diseases are due to viruses

Transmission is by mosquitoes (many of the genus *Culex*) or by hard ticks (of the genus *Ixodes*). These diseases are essentially diseases of fowls, horses, or other animals, and man becomes infected, as it were, by accident.

Symptoms. These diseases are often severe and fatal, but since they have not hitherto been common in the countries of the British Commonwealth (though found in East Africa, Canada, and Trinidad), it is unnecessary to describe them. Nevertheless, it is not beyond possibility for them to be introduced into mosquito- or tick-infested countries in which they could be widely spread

CHAPTER VI

RICKETTSIAL DISEASES: INSECT-BORNE

Fevers of the Typhus Group

THERE are four principal and several subsidiary fevers in this group, but they are linked together in that they are all due to rickettsiae, those minute bodies which are smaller than bacteria but larger than viruses, and are all transmitted to man by insects. The most

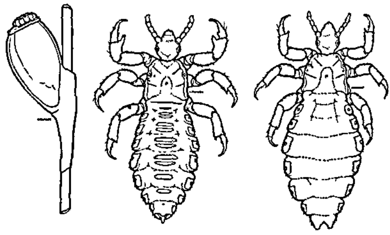


FIG 17 The human louse Magnified 12 times.
The louse carries typhus and one form of relapsing fever

convenient and the most practically useful classification of these diseases is according to the type of insect concerned, since, as in other insect-borne diseases, the characteristics of spread in a human community are determined by the habits of the vector insects and the suitability of environment to those vectors.

The four forms are:

1. *Louse-borne typhus*. This is transmitted from man to man, usually by body-lice, but it may be transmitted by head-lice. Lice become infected by sucking the blood of an infected person; after a few days they begin to pass out the rickettsiae in their faeces, and if the infected lice pass to another person, bite him, and pass their

faeces on to his skin, the rickettsiae may be introduced into his body through the skin puncture made in the act of biting. Human lice (*Pediculus humanus*) live only on man; they tend to leave a person in high fever, or a dead body, if another human host is available. They tend, therefore, to spread typhus in conditions of overcrowding. Lice thrive in conditions in which the changing and washing of clothing, and bathing, are not possible; they thrive, therefore, in winter and in crowded communities of the poverty-stricken. Typhus was known as gaol fever because it was common in prisoners, in British gaols of a bygone age, who were lousy and crowded; in more recent years it has been a disease of war refugees and of communities suffering famine and therefore driven to the slums of cities. It is common in eastern Europe, Egypt, and North Africa, Abyssinia and South Africa, in China and in Central and [illegible]

man if rats are not available, and the disease therefore spills over to man in this way. This form of typhus is found in association with rat-infested buildings, especially in seaports, it is compara- [illegible]

African relapsing fever) and, since these ticks will bite man if opportunity offers, man becomes infected by accident. This disease is found in South Africa (tick-bite fever), West and North Africa, southern Europe, the Americas, and elsewhere, *the most famous* [illegible]

Second World War, from the Maldive islands through Burma, Malaya, New Guinea, and other islands to Japan It is a disease of rats and is transmitted by certain mites[1] (*Trombicula*) which, in their larval stage, feed upon the rats, or upon man After feeding, these larvae leave the animal host, and further development takes place in vegetation. Adults develop, copulate, lay eggs from which

[1] Ticks and mites are not insects in the strict zoological sense.

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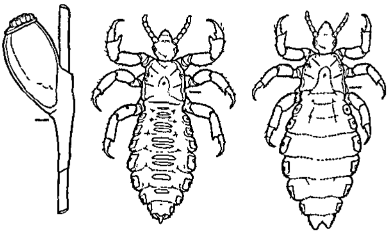
Egg (on hair) *Male* *Female*

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The louse carries typhus and one form of relapsing fever

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1. *Louse-borne typhus.* This is transmitted from man to man, usually by body-lice, but it may be transmitted by head-lice. Lice become infected by sucking the blood of an infected person; after a few days they begin to pass out the rickettsiae in their faeces, and if the infected lice pass to another person, bite him, and pass their

faeces on to his skin, the rickettsiae may be introduced into his body through the skin puncture made in the act of biting. Human lice (*Pediculus humanus*) live only on man, they tend to leave a person in high fever, or a dead body, if another human host is available. They tend, therefore, to spread typhus in conditions of overcrowding Lice thrive in conditions in which the changing and washing of clothing, and bathing, are not possible; they thrive, therefore, in winter and in crowded communities of the poverty-stricken Typhus was known as gaol fever because it was common in prisoners, in British gaols of a bygone age, who were lousy and crowded; in more recent years it has been a disease of war refugees and of communities suffering famine and therefore driven to the slums of cities. It is common in eastern Europe, Egypt, and North Africa, Abyssinia and South Africa, in China and in Central and [illegible]

[illegible]

rat to rat by rat-fleas. Infected fleas will, however, readily attack man if rats are not available, and the disease therefore spills over to man in this way. This form of typhus is found in association with rat-infested buildings, especially in seaports, it is compara- [illegible]

[illegible]

African relapsing fever) and, since these ticks will bite man if opportunity offers, man becomes infected by accident This disease is found in South Africa (tick-bite fever), West and North Africa, southern Europe, the Americas, and elsewhere; the most famous form is known as Rocky Mountain spotted fever. It does not occur in epidemic form in a human community.

4 *Mite-borne typhus* is also known as *scrub typhus* and *tsutsugamushi disease*, and became notorious in the Far East during the Second World War, from the Maldive islands through Burma, Malaya, New Guinea, and other islands to Japan. It is a disease of rats and is transmitted by certain mites[1] (*Trombicula*) which, in their larval stage, feed upon the rats, or upon man. After feeding, these larvae leave the animal host, and further development takes place in vegetation. Adults develop, copulate, lay eggs from which

[1] Ticks and mites are not insects in the strict zoological sense.

the larvae grow, and then the larvae seek an animal. Larvae normally take an animal meal only once, and if during that meal they take in the rickettsiae of mite-borne typhus, they cannot transmit the rickettsiae directly to a new host because they do not feed again on an animal. The rickettsiae, however, persist in the growing larvae and in the adults, and are passed on in the eggs to a new generation of mites, to be injected into new hosts when the larvae of the second generation take their animal meal Mite-borne typhus is associated with rat-infested land, very often land which has once been cultivated but subsequently become overgrown. The disease may be contracted in small areas, the intervening land being free; it is very localized, but if a body of troops camp in an infected area, or if labourers are working in such an area, an outbreak may occur. But it is not usually spread from man to man.

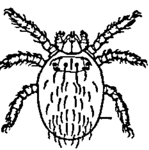

FIG 18. Larval mite of the genus which carries scrub typhus Magnified 60 times.

So far as is known, tick typhus is not spread by mites, or vice versa, and neither is spread by lice or fleas. Flea-borne typhus, however, may be transmitted by lice, and may, in that case, spread in human communities just as the true louse-borne form spreads: *the cycle then is rat—flea—man—louse—man. It is not known* why these rickettsiae are associated each with its own type of transmitting insect, any more than it is known why the malaria parasite can be transmitted only by *Anopheles* mosquitoes. These remarkable *biological preferences have no doubt been developed of necessity* in the course of evolution of the parasites, the transmitting insects, and the animal hosts. They serve to illustrate the complexity of the processes of nature, and to remind the reader that any simple conception of disease must be wrong.

Symptoms. The four forms of typhus are due to rickettsiae, which very closely resemble each other, and there is a corresponding similarity in the symptoms of the four diseases. The fevers begin somewhat slowly, *reaching high temperatures after a few* days. The patient becomes severely ill, and a rash appears on the skin of the body and limbs; this has been described as a subcuticular mottling, dusky red and sometimes with minute skin

haemorrhages. The rash, of course, is extremely difficult to detect in black skins. Headache is usually intense. The patient may become delirious and die, or, after an illness of 2 or 3 weeks the temperature may fall, either gradually or fairly quickly, and recovery may take place. The mortality rates of these diseases vary very greatly; they are especially dangerous to middle-aged and old people, and those who are badly nourished.

Diagnosis from other fevers is not easy before the rash appears, and even the rash is not always so characteristic that the diagnosis can be made. The diseases can be distinguished from other fevers (e.g. typhoid), and from each other, by blood tests, but for these special skill and proper laboratory facilities are needed. If any form of typhus is suspected, especially the louse-borne form, the public health authorities should be informed at once.

Treatment. Until recently no specific drug treatment was known, but the newly discovered chloromycetin and aureomycin have given extremely encouraging results. Success in treatment depends also on proper nursing. There is a danger of heart failure at the height of the disease, and the patient should therefore be nursed completely in bed. A fairly common complication is pneumonia, and for this the sulphonamide drugs are useful.

Prevention. The prevention of louse-borne typhus was at one time a most difficult and tedious matter, since it depended upon delousing large masses of people, and their clothing, by baths and steam heat respectively, under conditions of social disorganization and usually in cold weather. With the advent of DDT, however, the situation has been greatly simplified. Lice are extremely susceptible to DDT, and a powder containing 5 or 10 per cent of DDT in talc powder may be blown down the neck, up the sleeves and up the trouser legs of lousy persons, without the removal of clothing, and in a short time no living lice will be left on them. In this way large numbers of people can be deloused in a very short time, and as their clothing remains toxic for lice for some weeks, they do not become reinfested for some time. Dusting of a complete population in danger of typhus, in this manner, usually terminates an epidemic very quickly; it is usually a popular measure, since it removes lice, which are themselves a nuisance, without the necessity of undressing, and it certainly halts the disease.

But there is one other aspect of louse-borne typhus which is undoubtedly important. The rickettsiae, as explained above, are

CHAPTER VII

BACTERIAL DISEASES: INSECT-BORNE

Plague

Distribution. Plague is a disease of rats, field rodents, and man. It occurs in rat-infested towns and seaports, where rat harbourages abound, where grain and other foods are available to the rats, and where rats and man are closely associated with each other. It is constantly reported from most countries of Asia, from many parts of Africa, the Middle East, the U.S.S.R., and from North and South America. In England it was responsible for the Black Death and for the Great Plague of 1665.

Cause. The organism (*Pasteurella pestis*) which is the cause of plague is a bacterium; it has an oval shape, can be cultivated on artificial media, and is present in enormous numbers in the lymphatic glands or in the lungs or the blood of those suffering from the disease.

Transmission. Plague is essentially a disease of rats or other rodents, and it is usually spread from one animal to another by the fleas which normally live on them. These fleas pick up the infection when they bite and suck the blood of animals in whose blood the organisms are present. When the fleas swallow blood containing the organisms of plague, the latter multiply with great rapidity in the digestive passages and stomach of the fleas. At subsequent feeds the fleas eject these organisms during the act of feeding, probably because their food passages are blocked by the

the proboscis into the bitten animal. Like lice, fleas tend to leave dead animals, from which they cannot take the blood they need, and to seek living hosts; rat-fleas readily attack man if the usual rat-hosts are difficult to find. Rats are very susceptible to plague, and commonly die within a few days of infection; the discovery of large numbers of dead rats within a few days on ships or in rat-infested places, should lead to a strong suspicion of plague, and the dead rats should be collected carefully (since the fleas may attack the

collector) and sent for examination to a public health laboratory. If infected, the black house-rat is more likely than the brown sewer-rat to spread plague to man, since the black rat lives more closely in contact with man than the brown rat.

Plague in field rodents is known as sylvatic plague. These rodents (chipmunks, gerbils, squirrels, certain field mice, and other small animals) live in burrows in rural areas, and the disease may exist among them over large districts and for many years without more than an occasional human infection. But if hunters seek any of the animals in which the disease tends to occur, for instance the marmots of Manchuria, there is an immediate chance of human disease through the handling of diseased animals or from their fleas. If rodents which normally haunt human habitations are brought into contact with these field rodents and use, as they sometimes do, the same burrows, they form a link by which plague can pass from the field rodents to man—always through the intermediary of the fleas.

In a human community highly infested by the common human flea, the infection can be transmitted from man to man by this flea, but as a rule man is infected accidentally in the course of an outbreak among rats. Man may, however, infect man directly in another way. If in the course of the disease the lungs are attacked, as happens in a minority of cases, the plague organisms are abundantly present in the blood-stained material coughed up by the patient from his lungs, and his nurses and attendants are in serious danger of inhaling infective droplets which he tends to scatter into the air, and in this way to develop pneumonic plague themselves.

Certain fleas are particularly associated with outbreaks of plague, notably the tropical rat-flea *Xenopsylla cheopis*, found on rats throughout the tropical and sub-tropical world, and the rat-flea of temperate countries, *Ceratophyllus fasciatus*. But there is good evidence for the view that any flea is potentially a carrier of plague.

Both male and female fleas suck blood. The females deposit eggs on the ground, and the larvae which develop live in dust, feeding on débris, crumbs, or other organic material until for the pupal stage they spin cocoons in which they can survive, dormant, for several months. When the adults emerge they seek warm-blooded animals for their blood-meals.

Symptoms. There are three forms of plague, *bubonic*, *septicaemic*, and *pneumonic*. *Bubonic* plague takes its name from the bubo, which is an enlarged lymphatic gland, usually in the groin

but non-virulent plague bacteria are used, which are capable of stimulating immunity but incapable of producing plague. Administrative officers can be of the greatest service in using their authority to persuade or, if necessary, compel the public to submit to these public-health measures.

It is necessary, however to take permanent steps to reduce the rat population of houses, shops, bazaars, godowns, and ships, and so to construct buildings that rat breeding-places are reduced to a minimum, or that entry of rats is prevented. The technical devices employed are very numerous. For instance, since the black rat is a climbing rat, and tends to live in thatch roofs, other roofing material is to be preferred from this point of view; it is unwise to leave any hollow bamboo used for house building uncovered, since rats may nest in the hollows; tiles laid over roof-beams should not partially enclose small spaces which rats may use for nests; the lower part of grain stores or godowns should consist of unbroken concrete up to 3 feet from the ground, with an outwardly projecting ledge at that height, and all doors and windows should be above the 3 feet level; the foundations of godowns and other build-

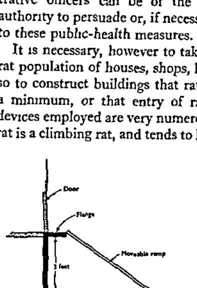

FIG 19 Rat-proof construction of walls

Ships are commonly infested by rats, and when they are tied up to the docks the rats may pass from the ships to the shore, or vice versa, along ropes or gangways. In this way ship rats infected with plague may start an outbreak of that disease in the dock rats, and this may spread to man; or infected rats from the shore may spread the disease to the ships. For this reason and because in the past devastating epidemics of plague have been traced to ports and to ships arriving from countries in which plague was endemic,

regulations relating to rat control in ports and on ships are stringent, but, of course, are difficult to enforce in small ports and for small craft. Ships may be fumigated with prussic acid preparations, and the same process may be used for storehouses, rat guards are placed on all ropes connecting the ships with the docks, all gangways are brightly illuminated or removed at night, since rats shun bright lights; all dock buildings should be rat proof.

Plague is often transported along inland routes of travel, especially in vehicles containing grain, in which rats tend to congregate, and outbreaks may occur one after the other along these routes. Prevention of such transmission is a matter of great difficulty and depends chiefly upon the general sanitary condition of the towns and villages along the routes. In Java some years ago there was a great epidemic of plague, which continued for many years, one of the most effective measures of control was the scheme for house improvement sponsored by the government, in which a subsidy was given for each house in which certain specified alterations were made so that rat breeding was discouraged. In addition a vaccine of living but non-virulent organisms was used with success. An interesting and unexpected complication of the house improvement service was that it entailed some digging, and that in the man-made excavations rain-water collected and *Anopheles* mosquitoes bred in large numbers, with the result that the incidence of malaria increased. This was later corrected by suitable anti-malaria measures.

For plague in field rodents, fumigation and poisoning methods have been used, but it will be clear that since the burrows of these rodents are scattered over enormous areas of land, the problem is of the greatest magnitude and complexity. Methods to solve it are still being sought.

Tularaemia

This is a bacterial disease of certain rodents, and it may be spread to persons, for instance, trappers, who handle these rodents, or by ticks or certain blood-sucking flies (*Chrysops*) which feed on the rodents and on man. It is found in America and in eastern Europe, but is not much in evidence in the countries of the British Commonwealth. It will not be described here.

CHAPTER VIII

SPIROCHAETAL DISEASES: INSECT-BORNE

Relapsing Fever

Distribution. Relapsing fever is found from China, through India, the Middle East, Africa, Europe, and North and South America.

Cause. Relapsing fever is due to spirochaetes, minute parasites which have a spiral shape, and which, in infected human beings, live in the blood. They are longer than the diameter of a red blood-cell, but are very slender; they are actively motile. There are several species which are differentiated from each other not on shape, size, or other visible character, but by virtue of the fact that they are transmitted by different arthropods, and because of certain differences in the immunity they provoke in animals. The spirochaetes are sometimes classified with the protozoa, but their position in this respect is somewhat doubtful.

Transmission. Relapsing fever is transmitted either by lice or by ticks. *Louse-borne relapsing fever* is found especially in human communities huddled together in conditions of squalor and cold; in these conditions lice flourish and migrate freely from one person to another, and if the infection is introduced into the community it is readily passed on. There have been extensive outbreaks in south-eastern Europe, North Africa, the Sudan, and elsewhere in fairly recent times. Lice take up blood when they feed; if this blood contains the spirochaetes (*Spirochaeta recurrentis*) of this particular form of relapsing fever, the spirochaetes undergo development and after a few days are found in the body-cavities of the lice. From these cavities there is no natural egress, and the spirochaetes can be liberated only if the lice are crushed; if this happens the spirochaetes are smeared on to the skin, and find their way into the blood probably through the punctures made by the lice in feeding. For spread from one person to another, therefore, an infected louse must travel from one to the other, and be crushed (in scratching, for instance) on the skin of the second person. Lice do not transmit the spirochaetes during the act of feeding, nor do they transmit them to their own offspring. Lice cannot live more than a few days away from man.

Tick-borne relapsing fever is transmitted very differently. The ticks (several species of the genus *Ornithodorus*) take in the spirochaetes (*Spirochaeta duttoni* and other species) from infected blood, and the spirochaetes multiply, reaching the salivary and other glands. They are deposited from these glands, either into the

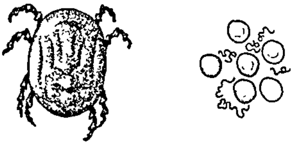

FIG 20
a Soft tick (*Ornithodorus*) Magnified 4 times
Carrier of one form of relapsing fever
b Spirochaetes of relapsing fever in human blood, with red blood cells
Magnified 1,000 times

blood or on to the skin, when the ticks feed again Ticks often live for several years, and retain the infection until death; moreover, they pass on the infection to their offspring for more than one generation Ticks can live for many months—even several years—without feeding; they are very difficult to kill. These ticks live in cracks and fissures in earth floors and walls of huts, and come out to feed at night. Certain species of *Ornithodorus* are found in the burrows of field rodents, in caves, and other places. They feed normally on rodents and other animals, but will attack man. Tick-borne relapsing fever is associated especially with rest-houses which are used by many successive travellers, and if the ticks in these houses become infected they may remain so [illegible] years, infe[illegible] ing travellers who use the rest-house [illegible] the travel in Africa and elsewhere should [illegible] and if they use them should take [illegible] bitten by ticks [illegible]

malaria, trypanosomiasis, and other diseases, since in the early stages *it has no special characteristics. After a few days,* however, the fever subsides rapidly, and the temperature may be normal for several days; then a relapse occurs, which is again followed by a few days of normal temperature. This alternation may be repeated several times, and is characteristic. It is important, however, that diagnosis should be made *in the early stages of the disease,* otherwise the period of normal temperature may deceive the patient into thinking that he has recovered, and correct treatment may be greatly delayed. Diagnosis is made by microscopic examination of the blood, the spirochaetes can be seen if suitably stained.

Relapsing fever may be fatal, or may do irreparable damage to the eyes and other organs; it is important, therefore, to give correct treatment as soon as possible. But even with early treatment success cannot be assured, and relapsing fever is as yet not as curable as some of the other tropical diseases Nevertheless, treatment has some value. The drug most commonly used is neoarsphenamine (N.A.B , neosalvarsan), which is given by intravenous injection, and which should be injected when the temperature is beginning to rise, but not when it is about to fall; if it is given just before the temperature falls the results may be serious. Treatment, therefore, is a matter which needs much care and judgement. On the other hand, the Central African type of tick-borne relapsing fever, though a severe disease in Europeans, is often relatively mild in Africans, and one or two doses of neoarsphenamine injected during the fever usually cure the latter. Penicillin is often successful in relapsing fever.

Prevention. Prevention of louse-borne relapsing fever is a matter of eradication of lice; this is dealt with in the section on louse-borne typhus above

Prevention of tick-borne relapsing fever is not difficult for Europeans. Rest-houses which may be used by travelling Africans, and which, therefore, are likely to harbour the ticks, should be avoided. A mosquito bed net properly fastened will keep out ticks, but the latter may creep into slippers or clothing left outside the net, and be packed up and carried away if the articles are not care-

which African labourers commonly travel from their home areas to the mines or plantations on which they engage to work, and is usually traced to the rest camps they use It is the duty of governments to maintain these camps, and they should be healthy. It is not always easy, however, to associate relapsing fever with any one particular camp, since the symptoms do not become apparent until a week or 10 days after infection has taken place, and by that time the travelling African may be many miles away from the camp at which he became infected Nevertheless, it is the duty of medical men to take care that blood examination is performed in cases of fever in travelling labourers, and, if relapsing fever is found, to attempt to trace its origin, and to notify its presence to the public health authorities. Moreover, it is the duty of the public health department to ensure that rest camps are carefully inspected for ticks, and that likely hiding-places are dealt with by application of DDT, pyrethrum, or benzene hexachloride.

If huts are badly infested it may be necessary to burn them completely, and rebuild them on a new site well away from the old. In constructing houses, special attention should be paid to the floor and walls. In Africa a mixture of cow dung and earth has been found useful as a covering for floor and walls, it does not crack and gives little harbourage for ticks. A cement floor is best, with cemented walls where possible, lime-wash helps to reduce tick harbourages. These ticks also live in thatch roofs, which, in spite of their admirable coolness, are better avoided

Administrative officers are closely concerned with the welfare of labourers and are expected to supervise all the arrangements made for them either by their employers or by the Government. Housing is one of the most important of these arrangements, and it is necessary that rest-houses and rest-camps, and the labour lines of mines and plantations, should be rigorously supervised No doubt much of this work is a responsibility of the public health department, but sometimes the rest-houses are remote from a responsible health officer. The administrative officer will do well to make it part of his business to see that these buildings are properly maintained.

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Tick-borne relapsing fever is fairly common along the routes by

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CHAPTER IX

THE INTESTINAL DISEASES

MANY diseases are primarily infections of the human intestine, and the causes of them include worms, protozoa, bacteria, and (possibly) viruses. It will be more convenient to describe the worm diseases together in a separate section, but those due to protozoa and bacteria have so much in common that they may be considered together. Though the causative organisms differ, the mode of transmission of these protozoal and bacterial diseases of the intestine is much the same.

The organisms are present in the faeces of patients suffering from the diseases, and in most cases diarrhoea is a prominent symptom. The organisms, therefore, are passed out frequently, are likely to contaminate clothing, bedding, utensils, and the fingers of the patient or of his attendants. In many of these diseases the patient continues to pass out the organisms in his faeces even after he has recovered, he is then a *convalescent carrier*, and usually does not know it He also, therefore, is likely to continue to contaminate his own fingers or clothing and, of course, any water with which his faeces may come into contact. There may, moreover, be *healthy carriers* who, though never having had symptoms, yet have been infected, and excrete the organisms.

It is evident, therefore, that if patients suffering from, or carriers of, these diseases live in conditions of bad sanitation, if their faeces are passed on the surface of the soil, or are thrown out from their houses on to the surface near at hand, or into streams or rivers, there is ample opportunity for infection if this surface contamination percolates, or is washed by rain, into the streams or wells nearby, and if this water is used unboiled.

Moreover, as is well known, flies are greatly attracted to human faeces, both as food and as a suitable material in which to lay their eggs. The feet of these flies may, therefore, pick up the organisms, or the flies may swallow them and subsequently pass them out on human foodstuffs. Flies are equally attracted to latrines and cook-houses

A person who is excreting these organisms and whose fingers become contaminated may, if he does not keep his hands scrupu-

lously clean, transfer the organisms to any article of food he handles. Those who prepare food are especially dangerous, for they may contaminate some article of food which may be an excellent culture medium in which the organisms can multiply, and by the time this is eaten it may contain a large dose of them. Thus, a milk dish, if not cooked after being handled, may be contaminated with a few typhoid bacteria, and in a few hours be swarming with them. A similar thing occurs, incidentally, when patients carry the acteria of certain diseases in their noses and throats, or in boils nd sores of the skin. The organisms are transferred to the foodstuffs, multiply, and are swallowed in relatively large doses.

Although this multiplication of bacteria in foodstuffs is important, and although some bacteria, for instance, many of the genus *Salmonella*, do not usually cause disease unless they are swallowed in large numbers, some of the more virulent bacteria, such as those which cause typhoid fever, are capable of originating their fevers even if only a few are swallowed. Typhoid fever outbreaks are often due to the drinking of contaminated water, yet the typhoid organisms do not multiply freely in water. Similarly, amoebic dysentery may be water-borne.

The typhoid bacteria, and others, if introduced into foods, for instance, ice-cream mixture, milk, or even cheese during the process of manufacture, and if these foods are subsequently kept warm for a few hours, will multiply enormously. But if the foods are cooked throughout for a reasonable time the bacteria are killed, milk boiled for a few minutes, for instance, is rendered harmless. On the other hand, if the foods are frozen immediately after they have been prepared, the bacteria will remain alive for days, but will not multiply until thawed. Cheese made from milk contaminated with typhoid bacteria may cause typhoid fever if it is eaten within a few weeks of manufacture, but the organisms do not find the finished cheese a congenial habitat; they die out gradually, and the cheese becomes harmless. It is, therefore, unwise to eat 'green' cheese.

In some tropical countries, and elsewhere, it is a general custom to use human faeces as manure in market gardens, and there is no doubt that faeces make an excellent fertilizer. The danger is, however, clear; it resides in the fact that in human faeces there are found the eggs of worms, the protozoa, and the bacteria which c[illegible] human intestinal diseases. If the growing vegetables or

supplies is more serious, as in Chicago. The entamoebae may also be carried by flies.

Symptoms. Amoebiasis occurs in several forms. It usually begins as a dysentery (known as amoebic dysentery), in which the *patient has some fever and much abdominal colic, and passes blood* and mucus in his stools at fairly frequent intervals. This form of dysentery may not be so severe as to compel the patient to take to his bed, and the diarrhoea is not usually so watery as in other forms of dysentery; on the other hand, it persists longer. If the patient is not treated, the entamoebae penetrate into the tissues of the intestinal wall and may be carried by the blood-stream to the liver. Here they may give rise to a general inflammation and enlargement of the liver (known as amoebic hepatitis) which is accompanied by local pain and fever. Sometimes there is localized destruction of liver tissue, and a liver abscess is formed, which contains the *characteristic pus (resembling anchovy sauce in colour)* and which may attain enormous size. Such an abscess may burst into the abdominal cavity, the lung, or rarely through the skin. In these affections of the liver the patient is rarely deeply jaundiced, but his skin usually has a sallow tinge

Treatment. For the early stage of amoebiasis the best treatment is by subcutaneous injections of emetine, followed by a course of emetine bismuth iodide (E.B.I) by the mouth. Emetine is a very powerful drug, with a strong depressing action on the heart. It must never be given unless the patient is in bed during the whole course of injections, and it should be given only by trained persons. The usual dose for an adult is one grain of emetine hydrochloride (dissolved in one cubic centimetre of sterile water) injected each day for a week or 10 days. Emetine bismuth iodide treatment is complicated and should be given only under medical supervision. *The reader is warned against using emetine himself.* This disease is not often a matter of acute urgency, and there is usually ample time for a medical man to be asked to see the patient and supervise treatment. Diodoquin and other drugs are also useful.

Amoebic hepatitis responds well to emetine, but *liver abscess* may need to be tapped to draw off the pus, or may even need operation.

Prevention. This is a matter of proper supervision of water supplies, proper disposal of faeces, and control of carriers. These matters are dealt with elsewhere in this book. There is no vaccine.

Other Intestinal Protozoal Infections

There are several of these, but it is very doubtful if most of them cause symptoms. Only one (balantidial dysentery) is of importance, and it is rare

Bacillary Dysentery

Distribution. This disease is world-wide, but is especially common in hot countries, where large numbers of carriers exist in the indigenous populations. It is responsible for part of the very high infant mortality which is a feature of tropical countries. It has always been a prominent feature of military campaigns.

Cause. Bacillary dysentery, of which there are several types, is caused by bacteria of the kind which at one time were known as bacilli, or rod-shaped organisms The scientific name of these bacteria has been changed to *Shigella*, but the old name has clung to the disease, to differentiate it from amoebic dysentery There are several species of *Shigella* (*S. shigae*, *S flexneri*, *S sonnei*, &c.), each of which is associated with a malady having general features in common with other members of the group, but having its own special characters also. The differences between these species, in some respects, can be determined only by expert bacteriologists, but the diseases they provoke differ chiefly in respect of severity Dysentery due to *S shigae* is much more severe, and causes more deaths, than the others; it is relatively common in hot countries *S sonnei* causes a mild diarrhoea, fairly common in Britain

These organisms can readily be seen through an ordinary microscope, but they cannot be identified thus, since many other intestinal bacteria have the same appearance They are motile, and are present in enormous numbers in the fluid faeces of the patients; they multiply very rapidly in the intestine, and in artificial culture media if kept at a temperature near that of the human body. They will similarly multiply rapidly in human foods if kept at that temperature, so that a contaminated food may, in a few hours, become charged with a heavy dose of these organisms.

Transmission. The mode of transmission does not differ essentially from that of the other organisms which cause intestinal disease, but it is true that bacillary dysentery is not so often a water-borne infection as is typhoid fever; nevertheless, in some countries (Java, for instance) bacillary dysentery is quite often water-borne. Healthy and convalescent carriers of these organisms abound in

known quite certainly that there has been no possible chance of contamination. Lettuce is a food in point; it is a ground vegetable liable to contamination from manure; it is handled by the gardener and by the person who prepares the salad; and it is normally eaten raw in Britain. But in the tropics, where human faeces are used for fertilizing market-gardens, where there are so many carriers of the dysentery and the typhoid organisms, and where the people have little or no knowledge of the principles of sanitation, the risks entailed in eating raw lettuce are usually too great. Moreover, in spite of the fact that some optimists think that to rinse lettuce in a solution of potassium permanganate is enough to cleanse it from all danger, it must be said that as a rule such rinsing is quite ineffective

These facts apply to strawberries, tomatoes, dates, &c., which are better cooked. Fresh fruit, and the vitamins, can be had as oranges, lemons, limes, bananas, mangoes, pineapples, and the other fruits which are protected from contamination by their thick skins.

Typhoid and Paratyphoid Fevers

These fevers are prevalent in all countries in which sanitary practices are primitive, and also occur in small epidemics in countries, like Britain, in which sanitation is at a high level. Fevers of this group should not be confused with typhus, though the name typhoid was originally given because certain symptoms resembled those of typhus, in the days when the distinction between the diseases was not clearly recognized.

Cause. These fevers are due to bacteria which in many respects resemble those of bacillary dysentery. They are motile bacteria which abound in the faeces of patients, and which are usually found in the blood at certain stages of the disease; they may also be present in the urine. The typhoid organisms, therefore, invade the tissues of the body more effectively than the bacteria of dysentery; they are more virulent, and the diseases are more serious than dysentery. The carrier state is quite common after recovery from fevers of the typhoid group, and carriers may pass the organisms in the faeces or in the urine for many years. A great number of outbreaks of typhoid have been traced to carriers. One of the most famous carriers was a woman in the United States, known as Typhoid Mary. She was a cook, and was responsible for many small epidemics in the households she served, and for a large number of

eaths. She refused treatment and would not believe that she was ausing these outbreaks; she constantly evaded medical super- ision, but finally the position became impossible, and against her ill, but for the protection of her potential victims, she was laced under restraint.

Transmission. These fevers are transmitted from man to man

licated.

Symptoms. The incubation period is from 10 to 15 days, and hen the patient's temperature rises, rather slowly, reaching its eight in a week. The patient is very ill, and there is usually diar- hoea, not very profuse, but in which the motions have been ikened to pea soup In the second week the rash appears, consist- ng of small rose-coloured spots on the body. The diarrhoea and ever continue, and the patient remains very ill and may develop ronchitis. In favourable cases the temperature begins to decline luring the third week, the diarrhoea decreases, and the patient egins slowly to recover. But in severe cases the patient may pass nto a semi-comatose state, or perforation of the small bowel may ake place through one of the ulcers which typhoid fever causes f perforation does occur, the only hope of saving the patient is to submit him within a few hours to a surgical operation, at which the perforated bowel is repaired. But it will be realized that an opera- tion on a severely ill person carries a great risk, nevertheless, if it is not done the patient will die. The diagnosis of perforation requires much medical skill, and it is evident from what has been said that for typhoid fever medical supervision is essential, much depends

Treatment. Until recently there was no specific treatment for fevers of the typhoid group, but the discovery of chloromycetin has now quite changed the position; it has been used with the greatest success in many cases, but it should be given early Efficient nursing is needed, and symptoms and complications should be treated as they arise. The details of these measures are much too complicated to be described; they involve the whole art of nursing. Aureomycin is also probably useful.

into a vein of a patient [illegible]

possible to give too much fluid, with disastrous results.

Such injections, of course, do nothing to kill the organisms, but they tide the patient over the most serious threat of dehydration, and enable him to combat the infection by the usual body defences With this treatment alone much success is achieved. Recently, sulphaguanidine has been used in addition to fluid replacement with some success, in doses rather smaller than those used for bacillary dysentery, viz 5 grammes at the onset, and then 2·5 grammes every 4 hours until a total of 20 grammes has been given Other sulphonamides have also been used, in smaller doses.

An older treatment which has been used in association with fluid replacement is the administration of potassium permanganate; one specially prepared pill, containing 2 grains, is given every ¼ hour for 2 hours, and thereafter every ½ hour until the motions become green. The maximum daily dose is 50 grains.

Prevention. This depends very largely on the control of water-supplies and on the provision of proper sanitary systems in the affected areas These are still far to seek in most cholera countries Medical control of religious fairs and festivals is progressing, and the quarantine stations through which pilgrims to Mecca must pass have done great work in protecting the main mass of the travellers on that pilgrimage. Vaccination has also been of great service, but the protection given does not appear to be quite so adequate as that given against typhoid by TAB vaccine, nor does it last so long, and in cholera countries it may be necessary to have the injection repeated every 6 months. Those actively engaged in dealing with outbreaks should be particularly careful to be inoculated regularly, and the value of the vaccine in controlling outbreaks, or in preventing them, is now generally accepted.

It is evident that epidemics of cholera may involve much administrative action and skill; control of religious pilgrimages offers scope for action offensive to the people, and ill-considered intervention may not only wreck the plans for that one outbreak, but may seriously prejudice the future. Medical men should always consult the administration before imposing emergency measures of control, and the administration should accept medical opinion, and guide its application

Sprue

Distribution. Sprue occurs in India, China, and the Far East; it has only very rarely been reported from Africa, but is known in the West Indies.

Cause. This is not known. Various theories have been proposed, but none has, so far, successfully explained all phases of the disease. There is no doubt that certain of the symptoms suggest deficiency of some of the vitamins, but since sprue occurs in Europeans who [illegible] adequate diet, and since it does not occur in [illegible] not dissimilar diet, [illegible] suggest that sprue the diet itself [illegible]

Transmission. There is some evid[illegible] some military units may occur as an epidemic, for instance, some military units stationed in India during the recent war were seriously affected, while others, not far away, almost escaped. Nevertheless, there is no direct evidence that sprue is, in fact, communicable from man to man; it may be that the conditions which produce it do so in many persons at one time, rather than that the disease is passed from one to another. Sprue is described here, among the communicable diseases, largely for convenience, in that it is an intestinal affection; but there is some epidemiological evidence to support the theory that an infective agent of some kind may be involved.

Symptoms. These usually develop slowly. The one prominent symptom is a form of diarrhoea in which a few motions are passed every day, especially in the mornings. These are soft, bulky, rather pale and fatty, sometimes frothy, and very offensive. The abdomen is often distended with flatus, and there is vague discomfort, without much pain The patient, otherwise, is thin, almost to emaciation, suffers from progressive anaemia, and has a sore tongue and mouth. He is weak, and, if not treated, may die.

Treatment. This is very complicated The diet must be carefully prescribed, and vitamins such as folic acid or nicotinic acid may be needed; preparations of liver are useful. This treatment must be given under the supervision of a medical man For the administrative officer it is enough that he should be able to recognize the disease, and apply for medical assistance. Sprue is not confined to Europeans only, but attacks them more than the indigenous inhabitants of the countries in which it occurs.

Prevention. This is still a mystery; it calls for no administrati[ve] action.

arsenical preparations, or penicillin, as in syphilis, though to a smaller total amount. Intravenous injections of three or four doses of 0·6 gramme of neoarsphenamine (for an adult), at intervals of one week, are usually enough for cure. Penicillin may supplant the other drugs. A preparation of bismuth sodium potassium tartrate, or bismuth salicylate (which is more effective), is also used for intramuscular injection. The bismuth and arsenical injections are often successfully given concurrently.

Prevention. The counsel of perfection would be to warn all the people to avoid contact with infective persons, but this would carry little conviction with those who regard yaws as inevitable, and who tend deliberately to infect their children young, rather than to avoid infecting them, on the view that it is best to get it over. These people do not dislike the idea of the infection, but they cordially approve of treatment when once infection has taken place. There is little doubt that general improvement in habits relating to bodily cleanliness, and in housing and standards of living, would greatly tend to eliminate yaws from any community, but this is a slow process, and attention should, therefore, be turned rather to campaigns of treatment on a large scale, for the control of this disease. A treatment campaign would have great chance of success *if all the* infective persons in the community could be induced to accept treatment Successful treatment campaigns have been conducted in most countries in which yaws occurs, largely by means of travelling teams.

Syphilis

Syphilis is not, of course, a tropical disease in the specific sense of that term, but it is so very prevalent throughout the tropics, and its effects are so baneful to its victims, that some description of it is desirable.

Cause. As mentioned above, the spirochaete of syphilis is very closely allied to that of yaws

Transmission. The usual mode of transmission is by sexual contact, but syphilis (unlike yaws) may be transmitted hereditarily from parent to offspring, the infant being born syphilitic. Patients with syphilitic sores of the mouth may give the infection to those they kiss, and there is in Iraq a rather unusual form of the disease, known as *bejel*, which is thought to be spread by *contact other than* sexual contact.

Symptoms. These are very diverse, and no systematic description can be given here. It is enough to say that there are three stages, primary, secondary, and tertiary. The primary sore occurs, usually on the genital organs, within a few weeks of infection; it is a small, rubbery, and painless swelling—a hard chancre. The secondary stage may be marked by some fever, and skin rashes The tertiary stage may be delayed for months or even years, and consists of chronic, slowly developing lesions of various internal organs, including liver and heart, bones or skin. Late sequelae of syphilis, which may develop years after infection, are general paralysis of the insane, locomotor ataxia (a disease of the spinal cord), and aneurysm of the aorta (a disease of the main artery leading from the heart), but these severe affections occur in only a minority of patients Syphilis is altogether a much more severe disease than yaws; it causes a considerable proportion of deaths, sooner or later, and is responsible for much sterility in women.

Treatment. This is not so easy as the treatment of yaws, though the drugs used are much the same The course of treatment of syphilis, even with penicillin, is much longer than that of yaws; it requires persistence A patient with syphilis should seek medical advice forthwith, and should follow up the treatment as long as is advised The fact that syphilis, though certainly curable, is much more difficult to cure than yaws, is the reason why treatment campaigns among the infected people of the tropics do not meet with the same success as in yaws. It is in some respects unfortunate that treatment of syphilis abolishes the visible signs of the disease—the sore, the rash, &c.—long before true cure takes place; patients who feel well, and see no obvious sign of the disease, tend to default from further treatment before it is safe to do so

Prevention. [illegible]

health problem of the very first magnitude. Some (but by no means all) of the ancient social customs of the people make for spread of these diseases because they do not discourage indiscriminate sexual intercourse. The [illegible]

concerned Missions have, in some places, taken an active part in

attempting to reduce irregular sexual intercourse, but in some instances it is thought that the emphasis laid on the notion of sin in relation to venereal disease has led to concealment, with bad effect on the patients and their partners and children alike.

The control of syphilis and the other venereal diseases is difficult enough in Europe and America, but it is far more so in the tropics, and from the medical point of view almost the only measure that can conceivably influence the position at present is the institution of treatment centres. Modern drug treatment, especially with penicillin, is so much more effective than the treatment in vogue only a few years ago, that the value of treatment in prevention is now considerable. From the social point of view it is to be considered how far preventive measures may be introduced into the structure of tribal custom, and how far the demands of industry should be allowed to take adult young men away from adult young women at a critical period of their lives. The arguments in favour of permanent labour forces, settled in married quarters, should be closely studied by the administration; this question lies at the root of many grave social problems which go beyond, though they include, that of venereal diseases.

Gonorrhoea

This disease is even more prevalent than syphilis throughout the world. It is too often looked upon as a trivial complaint, whereas, in fact, it sometimes leads to disastrous consequences, more particularly in women, and is a cause of sterility.

Cause. Gonorrhoea is a bacterial disease and it is transmitted during sexual intercourse, though it is also sometimes transmitted to the eyes of an infant at the moment of birth, as it traverses the passages of the infected mother.

Symptoms. In the male, a few days after infection, the signs

after a few days. In neglected cases inflammation may later spread towards the bladder, affecting the prostate (a gland adjacent to the bladder) or extending to the testicles; the organisms may also be carried into the blood, and set up inflammation of the joints. One not uncommon late result of gonorrhoea in the male is stricture of the urethra, a permanent narrowing of the lower urinary passage,

which may give great trouble. In the female the early symptoms are similar to those in the male, and later spread of the disease to the internal generative organs is common, causing blockage of the ovarian tubes, and consequent sterility, or abscesses of various parts.

Treatment. In the early days of the Second World War great success was attained in the treatment of gonorrhoea by means of the sulphonamide drugs, and a very high proportion of permanent cures was obtained when these drugs were given, in carefully calculated dosage, for a few days. When the troops moved into southern Europe, however, it was found that those infected with strains of the organism from European women were much more difficult to treat successfully than those who had been infected in North Africa. At the same time evidence was given in Switzerland that as time went on the sulphonamides were becoming less and less successful in treatment, whatever the dosage used. It appeared that some strains of the causative organism were resistant to these drugs, and that these resistant strains were becoming more and more prevalent. One theory to account for this was that it had become a common practice in Europe for infected persons to buy the sulphonamides themselves, and to treat the disease by taking a few doses, enough to allay the symptoms but insufficient to cure the disease completely, and that the result of this partial treatment was to stimulate resistance in the bacteria, so that they were able to live in spite of the drug. The other theory is that resistant strains already existed, that the susceptible strains were killed off by the drugs, but the resistant strains were not affected, and that gradually the resistant strains spread through the community, taking the place of those eliminated by treatment. Whatever the explanation, the fact remains that, although the sulphonamides still have value in the treatment of gonorrhoea, they are not so useful as they once were. It is wise for persons suffering from gonorrhoea not to treat themselves, but to submit to full courses properly supervised.

Recent experience has shown that penicillin is much more successful than the sulphonamides, and that success may be achieved by very short courses of treatment. As yet, penicillin is usually administered by intramuscular injection, and for this the patient should be under immediate medical control. Penicillin may eventually be the chief means of controlling gonorrhoea in tropical countries, but treatment on a scale sufficient to make an impression on

the general incidence of the disease would need a larger staff than is anywhere possible at present.

One danger of penicillin treatment is that a dose just sufficient [illegible] pens in a proportion of cases) would disclose the gonorrhoea first (as its incubation period is much shorter than that of syphilis) and if treated with the gonorrhoea dose of penicillin might not [illegible] danger; it is advisable that administrative officers should understand that treatment of disease may be a most complicated matter.

Chloromycetin appears to be very effective in the treatment of gonorrhoea; it has the advantage that it is given by the mouth. It is also useful in syphilis.

Other Venereal Diseases

Other venereal diseases are found in the tropics, but are much less common than gonorrhoea and syphilis. These are *soft sore*, *lymphogranuloma venereum* and *granuloma inguinale (ulcerating granuloma of the pudenda)*. Each is characterized by sores on or near the genital organs, and swelling or ulceration of the glands and tissues of the groins. Aureomycin appears to be most valuable in the treatment of the last two.

No further description of these is needed here; any patient who acquires a sore on the sexual organs, or who develops a discharge from those organs, should not attempt himself (or herself) to treat the condition, but should seek medical advice. If an administrative officer, in the course of his work, discovers that the people of his district are suffering from these diseases, he would be well advised to inform the public health authorities of that fact, if they, for any reason, are not yet acquainted with it. In remote areas the administrative officers very often observe, more closely than is possible for the medical staff, the intimate conditions of the people.

CHAPTER XI

LEPROSY: TUBERCULOSIS

Leprosy

Distribution. Leprosy is a fairly common disease, especially in tropical Africa, India, the Far East, the Pacific Islands, South and Central America, and the West Indies. It is particularly prevalent in West Africa and Burma and Assam. At one time there were many cases in Europe, but the incidence there has steadily fallen for several centuries, until now the disease has almost died out.

Cause. Leprosy is a bacterial disease, caused by an organism which closely resembles the organism which causes tuberculosis. The leprosy bacillus (*Mycobacterium leprae*) is found, in enormous masses, in the tissues of patients with one form of leprosy; in smaller numbers in those with the other forms, the bacilli are also present, from time to time, in the blood, and in the discharge from the nose.

Transmission. Leprosy is an infective disease, that is, a person does not become leprous unless the leprosy bacillus infects him from some other person. But, in spite of the evil reputation for infectivity given to leprosy in ancient and medieval times, it is, in fact, one of the least infective of diseases. The general opinion is that leprosy is usually only spread under conditions of close, intimate, and prolonged contact, such as the contact between a leprous parent and a young child. Children are, in fact, more susceptible than older persons to leprous infection, and it is very largely a family disease, though the infants of leprous persons are not infected before birth. Nevertheless, not all children of leprous parents develop leprosy. Theories attributing leprosy to hereditary factors, and to the consumption of certain articles of diet (fish, yams) have been advanced from time to time, but have largely been discarded, the theory of prolonged intimate contact remains valid. The organisms are discharged from the noses of patients with a certain form of the disease, and are probably scattered into the air in the acts of coughing or sneezing, later to be inhaled by those closely in contact with the patients. If the healthy contacts are susceptible to the disease (as infants appear especially to be), and

if the opportunities for infection are constantly present, the possibility of spread exists. Leprosy sometimes spreads from husband to wife, and vice versa; that it does not do so more commonly, in marriages in which one partner only is diseased, is probably due to the relative insusceptibility of adults.

Symptoms. Leprosy as a rule develops exceedingly slowly, and symptoms may not appear for several years after infection. Two main forms are recognized; the lepromatous and the tuberculoid forms. In lepromatous leprosy the bacilli are found chiefly in the skin, which becomes greatly thickened, especially on the face, forming swellings known as lepromata A patient with advanced leprosy of this type presents the so-called leonine face, thickened and deeply [illegible] the appearance of such patients has, no doubt, been very

[illegible]

cavities are often attacked, and ulcers form, which discharge the bacilli to the exterior in the secretions from the nose; and the larynx and lungs may also become diseased. Lepromatous leprosy is a more severe form than tuberculoid leprosy; it is more infective to others, and, though it develops slowly, does so more quickly than tuberculoid leprosy.

In the tuberculoid form the bacilli tend to attack the nerves, and interfere with their function. Sensation and muscular power, therefore, are diminished in the areas controlled by the affected nerves One of the early symptoms is loss of ability to feel pain, or loss of sensitivity to heat and cold, in limited patches of skin of the body, or in the arms or legs. A result of this is that trivial injuries of hands or feet may pass unnoticed, and may become infected with bacteria; in the absence of pain the patient tends to make light of such infected wounds and, moreover, the vitality of the tissues of the part is reduced because of the interference with nerve function. The result is a destructive ulcer, which often eats down to bone, and which does not heal well. If this process is repeated the fingers and toes are gradually lost, and it is not uncommon to see the unfortunate patient, not only without these digits, but with foul ulcers on the stumps of hands and feet. Muscular power is lost, and the arms or legs may be partly paralysed. If the disease affects the nerves of the body rather than those of the limbs, the first sign in a patient with a dark skin is usually a loss of pigmentation (i.e. a lighter skin) along the course of the nerve.

Patients with leprosy suffer great physical disability, and are usually much feared by the healthy. They are, therefore, often ostracized, and are usually unable to work. They become beggars, dirty, ill-nourished, and depressed Under these circumstances they are prone to develop other diseases; and death, when eventually it occurs, is usually due to some other infection, one of the most common of which is tuberculosis. Leprosy itself is not often the immediate cause of death.

Treatment. Various substances have been used in the treatment of leprosy, of which perhaps the most useful until recently was chaulmoogra oil Although complete cure is occasionally claimed, in the majority of cases treatment does no more than alleviate the condition The drugs are injected, and treatment must be continued for years Some of the newer synthetic chemicals are showing promising results, particularly promin and sulphetrone Promin is given by injection each day in courses lasting several weeks,

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ident

within a year of starting treatment. Sulphetrone has the advantage that it can be given by mouth; the results so far achieved with it are very good. These newer drugs may give rise to anaemia, and patients treated with them should be under skilled medical observation, but they are a great advance on the older drugs

Prevention. The reader will be aware that leprosy raises many human and social, as well as purely medical, problems The natural reaction of a community towards an individual who may be a danger to health, whose appearance is repulsive, and who is physically incapable of taking care of himself, is to ostracize the unfortunate sufferer or to compel him to live under restraint; the natural reaction for a diseased person who knows that the penalty for the disease is ostracism or restraint, is to conceal it. Many communities do not fear leprosy so greatly as to ostracize the patients, but some do, and even if the people themselves do not fear it, medical opinion, regarding it as a communicable disease, has in the past sometimes advocated compulsory segregation, and the conditions of this segregation have repelled some, though by no means all, of the patients On the other hand, voluntary segregation in leprosy institutions where the patients may lead a protected, but reasonably pleasant and useful life, is sometimes a very satisfactory solution of this difficulty, and it is now becoming more and

more appreciated that for segregation to be a successful means of preventing spread the institutions must be made attractive, and the psychological needs of the patients must be studied In all chronic diseases, in which the patients must inevitably feel with great force the fact that they are not as others are, that they are not important or useful members of society, or that they are considered of no account, the tendency to mental stress is very great, and many physically disabled persons, whatever the cause, become psychologically abnormal In leprosy this is very true. Nevertheless, patients with advanced nerve leprosy, who are partially paralysed, may reach the stage when they are glad of protection in an institution.

Prevention, therefore, is largely a matter of breaking that prolonged intimate contact which is the essential feature of the transmission of leprosy, and this is done either by the people themselves, as in parts of Africa where the leprosy patients are by tradition housed in small satellite villages, or through the agency of Government or Mission institutions. At these institutions there is a growing, and very wise, tendency to introduce simple industries to the patients so that they may, by doing useful work, recover some measure of self-respect, and earn a small wage. Administrative officers may help these institutions, partly by advice as to the activities that best suit the local people, and partly by giving the institutions their obvious support. In Nigeria there is a vigorous system, by which the medical staff of one large leprosy settlement visit certain clinics situated in a wide area, and there give treatment at definite intervals In this way they not only maintain touch with patients discharged from the settlement, but, as they gain the confidence of the people, can examine the families of the diseased, detect the early cases and treat them, or induce them to enter the settlement. This organization is highly successful; it has gained the confidence of the Africans, without which the effort would be wasted.

There is some evidence that resistance to leprosy is greater in the well-nourished than in the underfed; to raise the standard of nutrition in most tropical countries would, therefore, be desirable on this, as on other, grounds.

Tuberculosis

Tuberculosis is not one of the diseases generally known as tropical, but it is, nevertheless, one of the most important causes of illness and death in the tropics, and there is good evidence that in many of the hot countries it is increasing rather than decreasing in importance.

Cause. Tuberculosis is a bacterial disease, caused by an organism, the tubercle bacillus (*Mycobacterium tuberculosis*), which is related to that of leprosy

Transmission. Tubercle bacilli are discharged from the body of a diseased person in several ways, the most important of which is in the sputum, or in the droplets of mucus or saliva ejected from the mouth of a person suffering from tuberculosis of the lungs, in the acts of coughing, sneezing, or even speaking These bacilli, if inhaled by another person, may travel to his lungs and start in him the same tuberculous process Tubercle bacilli from tuberculous cows are often found in milk, and may infect man if he drinks it, but fortunately tuberculosis is not, in tropical countries, a common disease of cattle. The principal method of spread, therefore, is by the inhalation of infected droplets of sputum coughed, or otherwise scattered, into the air by persons with tuberculosis of the lungs; and it will readily be appreciated that opportunities for such inhalation infection occur most frequently in the houses in which tuberculous persons live, and that the people most likely to contract the disease are the children of tuberculous persons, who are most closely in contact with them Tuberculosis, therefore, tends to be a family disease, and it is probably true to say that some families are more prone than others to contract it, that there is an element of heredity in the susceptibility of people to tuberculosis, and, no doubt, to other diseases. Where infection is common, as in Europe, there has been a tendency for susceptible families gradually to die out, but in many tropical countries the disease is comparatively new, the susceptible families have not been weeded out, and in them the disease tends to be rapidly fatal, and to spread rapidly. The result is that the general picture of tuberculosis in such communities tends to be more severe than is usual in Europe. Tuberculosis is also particularly common in conditions of overcrowding, poverty, and malnourishment.

Symptoms. These need not be described in detail Cough,

more appreciated that for segregation to be a successful means of preventing spread the institutions must be made attractive, and the psychological needs of the patients must be studied. In all chronic diseases, in which the patients must inevitably feel with great force the fact that they are not as others are, that they are not important or useful members of society, or that they are considered of no account, the tendency to mental stress is very great, and many physically disabled persons, whatever the cause, become psychologically abnormal. In leprosy this is very true. Nevertheless, patients with advanced nerve leprosy, who are partially paralysed, may reach the stage when they are glad of protection in an institution.

Prevention, therefore, is largely a matter of breaking that prolonged intimate contact which is the essential feature of the transmission of leprosy, and this is done either by the people themselves, as in parts of Africa where the leprosy patients are by tradition housed in small satellite villages, or through the agency of Government or Mission institutions. At these institutions there is a growing, and very wise, tendency to introduce simple industries to the patients so that they may, by doing useful work, recover some measure of self-respect, and earn a small wage. Administrative officers may help these institutions, partly by advice as to the activities that best suit the local people, and partly by giving the institutions their obvious support. In Nigeria there is a vigorous system, by which the medical staff of one large leprosy settlement visit certain clinics situated in a wide area, and there give treatment at definite intervals In this way they not only maintain touch with patients discharged from the settlement, but, as they gain the confidence of the people, can examine the families of the diseased, detect the early cases and treat them, or induce them to enter the settlement. This organization is highly successful; it has gained the confidence of the Africans, without which the effort would be wasted.

There is some evidence that resistance to leprosy is greater in the well-nourished than in the underfed; to raise the standard of nutrition in most tropical countries would, therefore, be desirable on this, as on other, grounds.

Tuberculosis

Tuberculosis is not one of the diseases generally known as tropical, but it is, nevertheless, one of the most important causes of illness and death in the tropics, and there is good evidence that in many of the hot countries it is increasing rather than decreasing in importance.

Cause. Tuberculosis is a bacterial disease, caused by an organism, the tubercle bacillus (*Mycobacterium tuberculosis*), which is related to that of leprosy

Transmission. Tubercle bacilli are discharged from the body of a diseased person in several ways, the most important of which is in the sputum, or in the droplets of mucus or saliva ejected from the mouth of a person suffering from tuberculosis of the lungs, in the acts of coughing, sneezing, or even speaking. These bacilli, if inhaled by another person, may travel to his lungs and start in him the same tuberculous process Tubercle bacilli from tuberculous cows are often found in milk, and may infect man if he drinks it, but fortunately tuberculosis is not, in tropical countries, a common disease of cattle. The principal method of spread, therefore, is by the inhalation of infected droplets of sputum coughed, or otherwise scattered, into the air by persons with tuberculosis of the lungs; and it will readily be appreciated that opportunities for such inhalation infection occur most frequently in the houses in which tuberculous persons live, and that the people most likely to contract the disease are the children of tuberculous persons, who are most closely in contact with them. Tuberculosis, therefore, tends to be a family disease, and it is probably true to say that some families are more prone than others to contract it, that there is an element of heredity in the susceptibility of people to tuberculosis, and, no doubt, to other diseases Where infection is common, as in Europe, there has been a tendency for susceptible families gradually to die out; but in many tropical countries the disease is comparatively new, the susceptible families have not been weeded out, and in them the disease tends to be rapidly fatal, and to spread rapidly. The result is that the general picture of tuberculosis in such communities tends to be more severe than is usual in Europe. Tuberculosis is also particularly common in conditions of overcrowding, poverty, and malnourishment.

Symptoms. These need not be described in detail. Cough

sometimes the spitting of blood, and wasting are the classical signs of tuberculosis of the lungs; the disease usually develops fairly slowly, over a period of months or years, to the condition known as consumption, but the process may be rapid. Tuberculosis of bones, lymphatic glands, and other tissues gives rise to a variety of symptoms according to the site of the trouble. In all forms of tuberculosis it is important that the diagnosis should be made at the earliest possible moment, since success in treatment depends very largely on its early application. Early diagnosis in tuberculosis of the lungs may be difficult or impossible without the help of X-ray examination.

Treatment. This is long and difficult, and entails, above all, rest of the whole body and of the affected part of the body. It is unfortunately true that most patients suffering from tuberculosis of the lungs, in tropical countries, do not seek medical advice until the disease has advanced too far for treatment to be effective. Moreover, in the acute form so commonly seen, treatment is often unavailing even if started early. At best, however, the long period of rest which experience has determined to be the most effective measure of treatment makes great demands on the patience of the sick person, and in the absence of effective drugs and of quick results there is always a strong tendency for patients, especially in tropical countries, to seek other advisers in the hope of rapid cure, usually with disastrous results. In hospitals in which the more active forms of treatment are given it is to be hoped that results will gradually improve, but only a minority of patients are suitable for these treatments. Streptomycin has considerable value, and with para-aminosalicylic acid may be particularly useful in the tropics

Prevention. Although a preventive vaccine (known as BCG) has been developed against tuberculosis, the protection it affords cannot be regarded as more than partial, and the difficulty of preparation and administration of the vaccine has hitherto precluded its use in the British Colonies. Prevention, in other respects, entails the breaking of contact between the infective person and those who live close to him. This may be done either by inducing the infective person to live in hospital, in which case the hospital should be made attractive to him, or by inducing him at least to sleep away from his children, perhaps in his own separate hut. The sick person should be relieved of all tax, and, above all, there should be no

hut tax to prevent the building of a separate house for the infective person. Unfortunately, as the diseased person is usually infective to others for some time before he seeks medical advice, by the time he can be removed from intimate contact with his family the damage may already have been done to his children.

It will be seen that direct measures of prevention are difficult, and often disappointing. Tuberculosis is closely associated with poverty, bad housing conditions, and under-nourishment, and in the elimination of these disabilities, and in the improvement of general education and understanding of the principles of good health, lie the most promising possibilities of restricting the spread of this disease. It is largely a disease of towns and cities, where overcrowding and poverty exist, but it is not absent from, though much less prevalent in, rural communities.

Tuberculosis is particularly associated with certain industries, of which gold-mining is one of the most important In men who have some small focus of tuberculosis in a lung or a gland, which, under the quiet conditions of village life might remain harmless, the unaccustomed and severe physical labour of mining may cause the small focus to break down and spread The workman then becomes progressively ill, and therefore a danger to his companions. Moreover, in gold-mines there is usually a risk of silicosis, a disease of the lungs caused by the inhalation of fine quartz dust Silicosis predisposes to tuberculosis, and the two diseases are often found together. The prevention of tuberculosis in industry, therefore, entails good housing and feeding, constant supervision of the health of the workmen, and the institution of effective dust-suppressive measures in the mines. In South Africa there is comprehensive legislation to regulate the conditions of mine-workers; in some other countries the legislation is still inadequate, and the care of miners insufficient. In some tropical countries there is no Workmen's Compensation Act, and a man recruited for work, of which he has [illegible]

near the mine, being too poor or too weak to return to his own country; he is unable to support himself, and becomes a beggar for the short period left to him before he dies.

Administrative officers will recognize that such a situation should never have been allowed to arise, and should be ended forthwith.

This can be done only if proper legislation is introduced, and though it is beyond the power of the administrative officers to pass such legislation, they can at least press for it in their reports on their districts, taking care to support their recommendations by accurate statements of fact. Where large and influential commercial companies are concerned, reasonable suggestions for the proper care of employees are often accepted. If they are not accepted, administrative officers must be prepared to meet stubborn and powerful opposition.

CHAPTER XII

OTHER INFECTIVE DISEASES

ALTHOUGH most of the diseases described in this book are the so-called tropical diseases it would be a mistake to imagine that the diseases of temperate climates are rare in the tropics It is truer to regard the unfortunate inhabitants of hot countries as liable to most of the diseases of cooler countries, and, in addition, to those more commonly associated with warm climates. To describe these non-tropical diseases in detail, however, would serve no useful purpose; but to draw attention to their effects and causes may help towards understanding of their prevention

Many of these diseases are transmitted from person to person in the same fashion as tuberculosis of the lungs, the causative organisms—bacteria or viruses—are present in the droplets of sputum or saliva ejected from the mouth or nose of infected persons in the acts of coughing, sneezing, or even talking, and these fine droplets may be inhaled by other people The reader should not be under the impression that every person who inhales such infective droplets must necessarily acquire the disease, there is much in this question of infection which is not understood, and one of the factors concerned in it is the resistance to infection exhibited by the individual, which may be part of his natural constitution, or acquired as a result of previous infection with the same organism.

The bacterial diseases acquired in this way are scarlet fever, sore throat, tonsillitis, diphtheria, cerebrospinal meningitis, and pneumonia (though pneumonia often develops in the absence of direct infection—the bacteria which cause it being often present in the throats of healthy people, and the disease developing after some event which reduces resistance, for instance exposure to cold and wet). These diseases may become epidemic, and they may be very serious, especially in children Prevention entails isolation of the patient, closure of schools (in certain circumstances) or protective inoculation (as in diphtheria). Cerebrospinal meningitis attacks young adults as well as children; it may cause serious epidemics in troops, police, labourers, or other bodies of men living in barracks or other close communities, and it may be spread over wide areas

by healthy carriers in whose throats the organisms may be present, but who are not themselves ill. In epidemics of cerebrospinal meningitis, such as have taken place in East and West Africa within recent years, it may be necessary to place certain areas in quarantine, forbidding movement into or out of them. This interference with the freedom of the individual is justifiable in view of the danger of unrestricted movement, but should, of course, be abandoned as soon as the need has gone. The sulphonamide drugs are of great value in the treatment of scarlet fever, sore throat, and cerebrospinal meningitis; they are not useful for diphtheria. Penicillin is very valuable, but must be administered under close medical supervision, since it is given by injection.

Pneumonia may behave as an infective disease in labour lines or barracks, breaking out in the form of an epidemic. This has happened in South African gold-mines, and has been dealt with, partly by rehousing the miners in smaller rooms, holding fewer men, and by so constructing the sleeping bunks that the chance of infection from one man to another is diminished, and partly by the use of vaccines, which apparently have some value, though not so much as in many other diseases. The incidence of pneumonia in deep-mine workers is reduced if the men are given warm clothing to put on when they reach the surface (where the temperature may be low) after working in the hot and humid atmosphere of the depths of the mine Exposure to cold and wet is a common predisposing factor to pneumonia. The sulphonamide drugs are most valuable in the treatment of pneumonia.

The virus diseases transmitted by droplet are influenza, small-pox, chicken-pox, measles, mumps, and probably poliomyelitis (which is also spread by faeces). Influenza may sweep through tropical countries, as it does through colder countries, in epidemic fashion, as in 1918, and may be attended by a high death rate. In [illegible] being carried from island [illegible]

Small-pox has always been, and still remains, one of the most [illegible] communities and it is [illegible]

pox, between the day when infection is contracted and the day on which symptoms first appear, is usually 10–14 days, but in excep-

tional cases may be longer. A person newly infected, therefore, could travel far before the disease declares itself, even making a considerable voyage, and could pass the immigration authorities of the new country to which he has gone, and become lost in its population, in this way originating an epidemic. If it were not for the known efficacy of properly performed vaccination against small-pox, this risk of spread would be a great bar to international travel, since each country at risk would need to insist that no person be admitted until he had been at least 2 weeks away from any place where infection would be possible. As it is, however, the quarantine laws of most countries insist that all persons arriving from countries in which small-pox is prevalent must have been efficiently vaccinated. This regulation is usually effective, and admission of infective persons is now most exceptional; nevertheless, it does sometimes occur, and if the infected person settles in a population in which vaccination has not been thoroughly performed an outbreak may be expected. If such an outbreak does occur, the usual method of controlling it is to institute a vaccination campaign throughout the threatened area, and this is usually effective eventually, but not, as a rule, before a considerable number of cases and deaths have occurred. But to be useful vaccination should be properly done, and the lymph used must be fresh and potent. Small-pox is a disease of the greatest danger, and wherever it appears it must be dealt with at once. Chicken-pox, on the other hand, is a trivial affection, of no practical importance in itself, but it may be a source of trouble in that it is not always easy to decide, in the early stages, that a particular patient is suffering from the one or the other. This is of little moment if the disease is chicken-pox, but if it is small-pox it may be the beginning of a serious epidemic. If there are many cases, the general severity of the disease is a strong indication of its nature; in the individual patient the distribution of the rash is important in diagnosis. In chicken-pox the rash is chiefly present on the body, in small-pox the pocks [illegible]

In the event of an outbreak of small-pox the public health department will usually institute an extensive vaccination campaign, and will seek to forbid unauthorized movement of the people. This will call for considerable administrative action, and

From the characters of these eggs and spines the species of worm can be determined The eggs find their way through the wall of the veins, and the wall of the bladder or intestine, into the urine and faeces respectively, and are thus passed out to the exterior. If they are passed into fresh water the embryo worms hatch out of the eggs, and move freely in the water. If snails of suitable species are

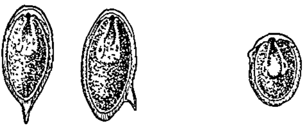


FIG 22 Eggs of schistosomes Magnified 200 times
a *S haematobium* *S mansoni*, *b* *S. japonicum*

present in the water, the embryos (known at this stage as miracidia) penetrate into the soft tissues of the snails and there undergo a process of development and multiplication. Once more that strange biological phenomenon of specific adaptation is apparent; these worms will develop only in snails of certain species, and the species are not the same for the three worms, though the worms themselves are so closely related. The miracidia cannot infect man.

In due course these embryos, now enormously multiplied in numbers, and changed in shape and character, begin to escape from the snails into the surrounding water. Infected snails continue to emit these embryos, known as cercariae, for several weeks. The cercariae are minute bodies, each with a tail forked at the end. By means of this tail they swim vigorously, and they are attracted to human skin or to the skin of certain animals, and only at this stage can man be infected. The cercariae usually live for only 24-48 hours in water, though they survive much longer in winter. If a man bathes in water containing these cercariae, or drinks it, the cercariae bore their way through the skin, or the mucous membrane of the mouth, and proceed to the next stage of development. It has been shown that the cercariae penetrate the skin as the water evaporates from it after bathing, and one measure which may do something to prevent infection is for the bather to dry himself

vigorously immediately after leaving the water, so that any cercariae present may be removed artificially, or destroyed, before they can penetrate.

Having penetrated the skin, the cercariae are carried in the blood-stream, grow, and develop to the adult stage in the veins they finally inhabit. The males and females come together, and fertile eggs are produced, which begin the cycle described.

a b c

FIG 23 Snail hosts of schistosomes, slightly enlarged.
a Bulinus (*S haematobium*). *b. Planorbis* (*S mansoni*). *c Oncomelania* (*S japonicum*)

Transmission. The snails commonly associated with the schistosomes of man are of the following genera:

Bulinus, *Physopsis* — *S. haematobium*,
Planorbis, *Australorbis* — *S. mansoni*,
Oncomelania *S. japonicum*.

All live in fresh water, and find admirable conditions in hot countries and in water which is stagnant or not moving too quickly. Rivers such as the Nile contain abundance of snails, and the canals of irrigation systems provide very favourable conditions for snails, which also thrive in ponds and lakes If urine or faeces are passed into relatively quiet water the miracidia from any schistosome eggs they contain have good opportunity to find the snails, and the cercariae emitted by the snails are not destroyed by movement, as happens in turbulent streams Schistosomiasis is closely associated, therefore, with irrigation. People who are exposed to these infections are usually exposed time after time, for years or for their whole lives. Reinfection is therefore the rule, though some immunity to infection is developed.

Symptoms. As the cercariae penetrate the skin they set up a severe irritation which may last several days. A few weeks later the patient *may suffer from fever, and occasionally from urticaria*

(a kind of nettle-rash, with itching and swelling of the skin of various parts of the body). In infection with *S. mansoni* and *S japonicum* he may experience symptoms of dysentery, which may be severe. In *S. haematobium* infections blood appears in the urine, and is passed in small quantities more or less continually as long as the infection persists, usually for many years. In all forms the spleen and liver tend to become enlarged—sometimes reaching enormous size—and a condition of anaemia and emaciation may develop in severe cases These illnesses are chronic, and may last for many years; patients with *S. haematobium* infections may experience little ill health, but *S. mansoni* and *S. japonicum* infections tend to be more serious On the other hand, complications may occur in all forms (such as inflammation of the bladder in *S. haematobium* infection), which produce permanent ill health, and all these diseases predispose to others, and may even be fatal themselves

Treatment. This consists of intravenous injections of preparations containing antimony One course consists of tartar emetic (sodium antimony tartrate), of which (for an adult) ½ grain is given intravenously, dissolved in 10 c.c. of freshly distilled sterile water. Two days later 1 grain is given, and the dose is increased by ½ grain on alternate days until 2½ grains are reached. This dose is given on alternate days (in 10 c.c. water) until 25–30 grains have been given in all. Care is needed in using tartar emetic; it is a dangerous drug if mishandled, and over-dosage may be fatal; it is intensely irritating, and causes abcess if injected into the tissues and not directly into the vein. Recently, tartar emetic has been given in an intensive course lasting only one or two days, but this requires expert supervision. Other antimony preparations such as Anthiomaline, Stibophen, and Fouadin are also extensively used, and can be injected intramuscularly. A new drug, Miracil, is giving good results.

Prevention. Personal prevention implies avoidance of waters which are infected, both for bathing and for drinking, unless they have been treated so that the cercariae are killed. Officers should inquire of the health department before attempting to bathe in streams or lakes, though salt water is quite safe from this point of view. If water for domestic use is infected, it is safe to use for a bath if it has been properly chlorinated or boiled. For drinking, all water not vouched for by the health department should be boiled, for this and for many other reasons.

Prevention in general is exceedingly difficult for the peoples of tropical countries, whose knowledge of the propagation of disease is negligible. It involves education in sanitary practice, and the construction and use of efficient latrines, but even with good latrines it is difficult to imagine means to prevent little boys from passing infected urine into the water of ponds and canals Boys also bathe in ponds and canals, and no amount of instruction and advice is likely to suppress that universal reaction to immersion in cold water, the desire to pass urine

If the administrative officer and the medical officer can induce the religious leaders of the community to issue a command that ponds, canals, and streams must not be fouled by human urine or faeces, no doubt much good will be done, but, once more, such injunctions are least heeded by the most infective section of the population, the children.

Various other measures are applied: irrigation canals are cemented, and dried and cleaned periodically; snails are caught by special netting traps; the water is treated with copper sulphate in certain doses, or with lime These are all important, but intricate, public health activities

Diseases due to other Schistosomes

Schistosomes of other species than those described above, and which are in nature parasites of birds, can enter the human skin and cause troublesome dermatitis (*swimmers' itch*), *but they cannot* develop in man, and do not, therefore, cause any form of general disease.

The Liver Flukes

The liver fluke of Europe and other continents, *Fasciola hepatica*, is a parasite of sheep. Eggs passed in the faeces of sheep, if they enter fresh water, hatch to embryos which penetrate snails (*Limnaea*). The cercariae which emerge from these snails attach themselves to grass or other plants, and sheep become infected by eating such grass. Man usually acquires the infection by eating contaminated watercress, but this parasite is rare in man

On the other hand, the tropical liver fluke (*Clonorchis sinensis*) is responsible for much human infection in China and other far eastern countries, and is also a parasite of dogs, cats, pigs, rats, mice, camels, and badgers. The eggs are passed out in human or

animal faeces, and if into fresh water they may be ingested by snails of the genus *Bithynia* (and others). From these snails the cercariae escape in due course and penetrate the skin of certain freshwater fish, *to encyst in the muscles and under-scales.* If the fish are eaten by man, and have not been cooked sufficiently to kill these encysted embryos, the latter develop in the human stomach and pass to the liver, where they cause extensive disease, sometimes fatal. It is a common Chinese practice to eat fish only lightly cooked, or pickled, and infection with *Clonorchis sinensis* is relatively common in China More than 30 species of fish, including gold-fish, act as hosts for this fluke.

Treatment of this infestation is very unsatisfactory. Prevention consists, for the individual, either in avoiding freshwater fish, or in ensuring that they are properly cooked. As this is a serious disease officers in the areas concerned would be well advised to avoid these fish altogether; salt-water fish are not subject to this infection. In general, no doubt, the spread of the infection will be checked as good sanitary practices are adopted, but it will be a long time before this happens.

The Lung Fluke

This fluke (*Paragonimus ringeri*) is found in China, Japan, and the Far East; it is a parasite of man, dogs, wolves, leopards, and cats, and in these animals it finds its way into the lungs, where it lives, taking its nourishment at the expense of the lung tissue, *which it slowly destroys. The eggs are passed out to the exterior* in the sputum of the patient, which usually also contains some blood. If the patient spits into fresh water, the eggs hatch into embryos which enter snails of the genus *Melania.* The patient may, [illegible] the eggs are passed

[illegible]

which penetrate the tissues of certain freshwater crabs (genera *Potamon, Eriocheir,* and others) or crayfish. In these the embryos encyst and can remain alive for long periods. If man eats infected crabs which are insufficiently cooked, the embryos develop in the human stomach, and after a complicated journey they find their way to the lungs In China it is a general custom to eat crabs which have been steeped, raw, in wine, and which are not even dead; similarly, crayfish are eaten in the raw state.

Treatment is most unsatisfactory, and, as this is a very serious disease, officers should be at pains to avoid all chance of infection. This can only be ensured by refusing to eat crab or crayfish in any form Thorough cooking, of course, kills the parasites, the difficulty is to ensure that cooking is *always* thorough enough. Prevention in the general population is possible, but evidently difficult.

There are several other flukes which infest man, but they are not so important, and do not give rise to conditions so serious as those described above

Cestodes

Four of these tapeworms have importance to man The worms are flat, and consist of a head, and segments The smallest has a head and 3 segments, the others have hundreds of segments Each segment contains male and female reproductive organs

Diphyllobothrium latum

Diphyllobothrium latum (formerly known as *Dibothriocephalus latus*), the broad tapeworm, is found in very different climatic conditions, it is relatively common in Finland, but also occurs in Japan, Madagascar, and Africa. The adult worm inhabits the intestine of man, dogs, cats, bears, and other animals, it may attain a length of 10 feet, consisting of a head and very numerous segments. These segments often become detached, and are passed in the faeces, and since they are the older segments, farthest from the head, they have lived long enough for the male organs to have fertilized the female, and to have produced eggs If these eggs reach fresh water they hatch to embryos, which may be swallowed by the small crustaceans known as water-fleas (*Cyclops* or *Diaptomus*). In these water-fleas the embryos undergo a cycle of development, and when the water-fleas are, in their turn, swallowe by freshwater fish (pike, perch, trout, salmon, and others) th embryos penetrate into the muscles and other tissues of the fis and continue their development. Man becomes infected by eatin infected fish which have not been cooked sufficiently thorough to kill the worm embryos, and in the human intestine the mat worm develops.

This worm may cause a form of anaemia The treatm designed to expel the worm is the same as for the other tapew described below. To avoid this infestation, in countries whe

Taenia saginata

Taenia saginata, the beef tapeworm, undergoes a life cycle similar to that of *T. solium*, except that the cyst stage occurs in cattle. Man acquires the worm by eating underdone infected beef, and a warning against that peculiarly British dish, underdone roast beef, is therefore necessary Thorough cooking will kill these cysts, but they can persist alive in underdone beef. Treatment of this infestation is the same as for *T. solium*.

There is no evidence that *T. saginata* has ever caused cysticercosis in man, but the reason for its inability to do so is not known.

Echinococcus granulosus

Echinococcus granulosus is the smallest of the tapeworms, consisting of a head and 3 segments only. The adult worm is a parasite of the intestine of dogs and other animals, and man is infested as a result of swallowing fertile eggs passed out with the faeces of the infested dogs, and the worm develops its cystic stage in the tissues of man. Cattle and sheep are similarly the hosts for the cystic stage of this worm. It is a matter for conjecture how eggs from the faeces of dogs may be swallowed by man, but it is possible that the dog's muzzle may be contaminated, and that the eggs may be transferred to the hands, and thence the mouths, of children who fondle the dogs. Similarly, if dogs are allowed to lick plates used for human food, the minute eggs may be transferred to the plates and thence to the human mouth Whatever the route, people who live in countries in which dogs are infected would be wise to avoid keeping them if there are children in the house, and even adults are by no means immune The human disease, known as hydatid disease, is serious, since the cysts, unlike those of *T. solium*, may develop to enormous size in the liver, lungs, and other organs. The cysts, which contain the embryos of the worm, are large because of the enormous amounts of fluid they contain.

Cattle and sheep become infected if they graze where dogs have deposited faeces containing the eggs, and cattle and sheep develop these large cysts, acting, like man, as the intermediate hosts. Dogs become infected by eating the infected meat of cattle and sheep; the presence of the minute adult worms in the intestine of the dog does not cause any demonstrable disease.

The symptoms of hydatid disease in man are largely due to the

mechanical effects of the cysts. These, as they grow, tend to destroy by pressure the normal tissues of the organs in which they are situated, or to displace these structures; and, in general, attention [illegible]

[illegible] difficult, and the whole subject is so complicated that no more than the bare mention of it can satisfactorily be made here. Treatment usually necessitates surgical operation. Prevention involves control of slaughter-houses, and avoidance of contamination from dogs

Hydatid disease is common in Australia, North Africa, and South America, and occurs in many other countries

Nematodes

The nematodes are the roundworms, the longest is several feet in length, the shortest only a few millimetres All are round on cross-section, and the males and females are distinct, they are not hermaphrodites like the cestodes and some of the trematodes Some of these worms inhabit the human intestine, some the blood, and some the other body tissues Some are acquired by swallowing the eggs, some by penetration of the skin by larvae, and some are transmitted by biting flies or mosquitoes.

Ascaris lumbricoides

This is the comm [illegible] in the small intestine of man, but occasionally wander to the stomach, mouth, bile ducts, and other places

The worms copulate in the intestine, and the females emit enormous numbers of fert [illegible] T [illegible] th [illegible] small, active larvae The course of the infection then becomes complicated. The larvae penetrate the intestinal wall and are carried by the blood-stream through the heart to the lungs, thence they ascend the trachea (windpipe) to the back of the throat, are swallowed, again reach the stomach and intestine, and there develop to adult life. This remarkable journey, which has again and again been confirmed, is essential to the development of these embryos,

but the reason for it is as little understood as the other complex biological processes which are such a feature of tropical parasitology; it is a complete mystery why the embryos direct from the eggs, once in the human intestine, cannot peacefully develop to adult life there, but it remains a fact that they cannot do so without travelling through the lungs Sometimes, in this journey, they set up severe disturbance of the lungs. Otherwise, *Ascaris lumbricoides* cause relatively little trouble unless many are present, when they may become tangled into a knot or mass, and obstruct the intestine. Over 1,000 of these worms have been found in a single patient, but as a rule there are less than 100. From time to time the worms are passed out in the faeces.

Infection with *A. lumbricoides* is likely to occur only in communities in which the standards of sanitary practice are primitive, and it implies usually the soiling of hands from contaminated earth. It is particularly an infection of children, especially at the 'dirty age', when the natural reaction is to put everything to the mouth, and when they crawl on ground soiled with faeces. It is, therefore, prevalent in countries where sanitation is deficient.

Treatment. Santonin ($\frac{1}{2}$ to 1 grain for a child; 3 to 5 grains for an adult) has long been successfully used to eliminate these worms; it should be given on 3 successive nights, the first and last doses being followed by castor oil the following morning

Hexylresorcinol and carbon tetrachloride are also used; the doses are given below under the heading of hookworm infestation

Prevention. *This is essentially a matter of good sanitary* habits and appliances.

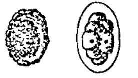
Hookworms

Two hookworms develop to maturity in man, *Ancylostoma duodenale* and *Necator americanus.* The name of the latter is misleading in that the worm occurs widely outside America, as well as in that continent.

These worms are round; the sexes are separate. They are equipped with teeth, or cutting plates, by means of which they attach themselves to the mucous membrane of the small intestine, and they suck the blood of the host for their own nourishment. The worms, when fully developed, are about $\frac{1}{2}$ inch in length, and slender. Each worm, therefore, takes only small quantities of blood, though relatively large in proportion to its own size, since

[illegible]

protein, so that the losses of these constituents are not made up. Haemoglobin, the red pigment of blood, is the means by which oxygen breathed into the lungs is conveyed to the tissues throughout the body; it contains a high proportion of iron, and without iron and protein haemoglobin cannot be formed The oxygen-carrying capacity of the blood is, therefore, reduced in heavy hookworm infection in a badly nourished person, because haemoglobin is lost as the hookworms take blood, and is not adequately replaced if the diet is poor



Ascaris (round-worm) *Ancylostoma* (hook-worm)

FIG 24 Eggs of *Ascaris* and *Ancylostoma* Magnified 200 times

Other essential substances are also lost, and the result is anaemia

The worms copulate in the human intestine, and the female emits enormous numbers of fertile eggs, which are passed out in the faeces If these [illegible]

these feeding larvae, and move into the moist earth These larvae possess the power of penetrating the human skin They remain quiescent in the cold, but are attracted to warmth, and therefore to human skin if that is in contact with the ground near to them These larvae can travel a few feet from their place of origin, but only in moist soil; it must be remembered, however, that soil below an apparently dry surface may contain enough moisture for these embryos.

In tropical countries it is a usual practice for the people to defaecate at any convenient spot, but they prefer secluded sites. These are provided by trees and bushes, and under this vegetation the soil tends to retain its moisture, and is protected from direct sunlight. The conditions are therefore good for the hookworms, and it is to precisely these situations that the people tend day after day to retire, so that their bare feet rest on soil containing the infective larvae, which are attracted to the skin and penetrate it. The thick, horny skin of the soles of the feet is impervious to them,

but they penetrate the thinner skin of the sides of the feet and the ankles. Having penetrated the skin, the larvae are conveyed along the lymphatic channels and blood-vessels to the heart, thence to the lungs, up the trachea to the back of the mouth, from where they are swallowed, *to reach the small intestine, where they mature,* attach themselves to the intestinal wall, and mate. Once more the complicated route is traversed, similar to, but not identical with, *that of Ascaris lumbricoides,* which, had it not been so completely confirmed, would be almost incredible. From the point of view of public health, the important fact is that hookworm infection is contracted through contact of the skin with infected soil containing free larvae, whereas infection with *Ascaris lumbricoides* depends on swallowing the eggs of the worm.

On plantations, for instance of coffee trees, the conditions of moisture, warmth, and shade are usually ideal for the development of hookworms, and the labourers are often heavily infected. The same is true of mines.

Symptoms. As the larvae work their way through the skin they give rise to an irritation known as ground itch, which usually passes off in a few days as the larvae are carried away. The patient newly infected with hookworms may experience disturbance of the lung as the embryos pass through that organ, and dyspepsia as they develop in the intestine. These symptoms pass off, and if only a few worms have penetrated the skin there may be no further *trouble.*

If many worms have entered—and it should be remembered that the patient may repeatedly be reinfected—and if the diet is poor, *the patient becomes anaemic, as has been explained,* and the consequences of anaemia become apparent. The patient is feeble and incapable of full work, apathetic, pale (if his skin is white), and may suffer from swelling *of the legs from a kind of dropsy.* In this anaemic state he is predisposed to infective and other diseases, which further increase the degree of anaemia.

Treatment. Several drugs are used *to expel the worms,* with success, but it is well to remember that a patient with a severe degree of anaemia should be given a good diet containing adequate meat and green vegetables, and a course of *iron, for several* weeks before the powerful drugs for elimination of the worms are administered. Patients not in a state of severe anaemia may take them without delay.

Carbon tetrachloride has been much used. The dose for an adult is up to 60 minims, given with water on an empty stomach, and followed ½ hour later by a dose of salts (½ oz) This is an effective drug, but has been responsible for death in some cases, and should therefore be used with caution, especially in enfeebled patients. Thirty to forty minims of carbon tetrachloride may be given with 12 minims of oil of chenopodium.

Tetrachlorethylene, chemically related to carbon tetrachloride, is a much safer drug, and is practically as effective The dose is up to 60 minims for an adult, and it should be followed by a dose of salts

Hexylresorcinol is also used; the dose for an adult is 1 gramme Thymol may be given, 60 grains for an adult, divided into three doses of 20 grains (each in a rice-paper cachet) given at intervals of one hour, and followed by a dose of salts

For women and children smaller doses of these drugs are given, in the usual proportions.

Prevention is a matter of sanitation and education, the provision and proper use of latrines are essential to hookworm eradication. The wearing of shoes is also effective against infection, but to issue shoes to the general population is not as a rule successful, since they are usually not worn continuously, and are discarded while the person concerned is about his or her domestic affairs, and it is round the worms that the risk of infection is greatest

Threadworms (Pinworms)

These small worms (*Enterobius vermicularis*) live in the large intestine of man. They are about ¼ inch long The females migrate, in the night, to the folds of skin at the anus, and there deposit their fertilized eggs. These eggs may become attached to the fingers, especially as the movements of the worms cause itching, relieved by scratching. Or they become attached to the clothing or bed-clothing, or are shaken into the air. From these situations they may be conveyed to the mouth, or inhaled, and swallowed, and they develop into adult male and female worms in the intestine Infection is common in children, and often runs through a family

FIG 25 Eggs of tape worm and threadworm Magnified 300 times

The worms cause no serious disease, since they do not invade

the tissues, but their activities cause irritation which disturbs sleep, and they thus to some extent interfere with healthy development.

Treatment. This is not easy. Enemata may give relief and bring away many worms. Drugs are useful, but should be given only under medical supervision; of these gentian violet is perhaps as useful as any.

Prevention. The eggs are present in faeces, but spread of the infection is not usually bound up with contamination by faeces, but rather with finger contamination and the swallowing of eggs contained in dust and air. Prevention is therefore exceedingly difficult. Threadworms are by no means uncommon even in carefully brought-up children. If one member of a family is infected, all members should be examined, and treated if necessary. One infected and untreated member will quickly reinfect the rest, and a patient tends to reinfect himself repeatedly.

Several other nematode worms infest the human intestine, but they are either rare, or unimportant, and need no mention here.

Trichinella spiralis

This nematode is important because it gives rise in man to severe symptoms, and because it is contracted from undercooked pork It is found throughout the world.

The worms (male and female distinct) are only just visible to the naked eye, up to 4 millimetres long, and very slender. They live in the small intestine of the host (pig, rat, man) and copulate there. *The females give birth, not to eggs, but to minute embryos,* which penetrate the wall of the intestine and are carried by the blood to all parts of the body. In the muscles they form small cysts and remain in them, dormant and unable to develop further. When this infected flesh is eaten by another animal the embryos are *set free* as the muscular tissue is digested, and continue their development to adult life in the intestine of the new host. Man acquires the infection by eating infected and undercooked pork, sausages, or other forms of pig flesh. Pigs acquire theirs by eating dead rats or infected pig flesh; rats eat each other and anything else they can find.

Symptoms. Shortly after eating heavily infected meat the patient experiences a form of dysentery, with fever, owing to the invasion of the intestinal wall by the larvae, and later a typhoidal condition, with severe muscular pains, may supervene as the larvae are spread through the body. In a few weeks, when the larvae have

become encysted, the patient may become emaciated, and there may be oedema (dropsy) of the face, abdomen, and legs Death may be caused, but most patients slowly recover There is no effective treatment.

Prevention. The one sure measure is to ref[illegible] meat unless it has been th[illegible] be protected by [illegible] meat In the Un[illegible] [illegible]ection is not rare, it is recommended th[illegible]e garbage given to pigs as food should be cooked to kill any cysts present in meat included in the garbage. Rats should be suppressed.

The Filariae

This group of nematode worms is of great importance in the ropics. The adult worms (male and female separate) live either n the body tissues or the lymphatic system, and the females give irth, not to eggs, but to embryos which are either passed out to he exterior of the body, or which enter the blood or the tissues beneath the skin. Embryos passed out of the body gain access to other persons through the mouth; those in the blood or sub-cutaneous tissues are taken up by biting flies or mosquitoes and are transferred to new hosts much as the malaria parasites are transferred.

Guinea Worm (Dracunculus medinensis)

This is the largest of the filariae, the mature female measuring several feet in length, but having a thickness of only about 1½ millimetres. It is a common parasite of man in West Africa, the Sudan, India, and elsewhere.

The adult, fertilized female lives in the tissues beneath the skin of the body or limbs of man, and usually tends gradually to seek the most dependent parts. This female is filled with thousands of minute embryos, and when the time is ripe for her to discharge this mass she approaches the surface of the skin, and causes a small blister to appear on it. This blister is painful, and the pain may be alleviated by bathing it in cold water When this occurs the blister bursts, and the worm, contracting, ejects through the open blister some of the enormous numbers of embryos she contains Very often the bathing process is carried out at a well or pond, and the embryos so discharged find their way into the water If this water contains those small crustaceans known as water-fleas (*Cyclops*,

which are also referred to above as intermediate hosts of the broad tapeworm), the embryos are swallowed by the water-fleas, and undergo a stage of development in them. If now these infected water-fleas are swallowed by man (or dogs and some other animals), the embryos are liberated and penetrate the wall of the intestine, thus entering the tissues of the body. The further stages of development in man are not known in detail, but 10 to 12 months later *the adult female may be found beneath the skin in the places* described. The male worm is much smaller than the female, and it apparently dies and is absorbed soon after it has performed its *function of fertilizing the female. Nor is the latter much more* fortunate, for she dies after having completely ejected her young, a process which takes some time, as she discharges only part of the contents of her uterus at a time.

The female guinea worm herself does little damage to man, and causes little disability, until she dies. Then the body of the worm lies inert in a long track which is open to the exterior by the aperture in the skin through which she discharged her embryos. If bacteria gain admission to this track, as they are quite likely to do, they may develop rapidly in the disintegrating tissues of the dead worm, and cause a spreading septic infection along the track, and a considerable ulcer at the aperture. Abscesses may develop along the limb, and the patient may become seriously ill. In West Africa this commonly happens, and it is not unusual to find a very considerable proportion of the population disabled for work for some weeks during the season when guinea worms mature; so much so, indeed, that there is a serious interference with agricultural work, *often at a time when every effort is needed to attend to the land* Moreover, these septic infections do not heal until the dead worm, which acts as a foreign body, has been removed or absorbed

Treatment. *When the worm has completed* the process of discharging embryos, and is dead, it can often be drawn through the skin by gentle traction, and women in West Africa become very *expert in this process, winding the worm round* a twig of wood which they rotate little by little. If the worm breaks, the result may *be serious because of the sepsis which may develop.* Various surgical procedures *have been devised to ensure that the* whole worm is removed, and the officer unfortunate enough to acquire one of these worms (which is a rare event for a European) would be well advised to *leave treatment to a medical man.*

Prevention. Water should not be drunk unless it has been boiled, or is certified by the public health department as fit for drinking. Boiling will kill the water-fleas and the embryos of the guinea worm, and even filtering will remove the water-fleas. But filtering should not be relied upon; boiling is safe.

Wells should be so constructed that water drawn from them, if spilled near the top, cannot run back into the wells. If water is used for bathing the affected limb, and this water becomes laden with embryos, the embryos cannot gain access to properly constructed wells, and therefore will not pass into the water-fleas. Wells known to contain water-fleas may be cleared of them by heating the water by means of a steam generator, or by chlorination.

Wuchereria bancrofti and W. malayi

These are the commonest of the filarial worms. *W. bancrofti* is found throughout the tropics in Africa, Asia, the Pacific, and America; *W. malayi* is found in the Far East only.

These are small, hair-like worms, males and females being separate. They live in the lymphatic glands, and the females produce embryos which find their way into the blood, and can be seen in smears of blood examined under the microscope. These microscopic embryos, when taken up by certain (female) mosquitoes, undergo in the mosquitoes a cycle of development, and when the mosquitoes feed again after this cycle has been completed the embryos penetrate the skin of a fresh human host, to develop into adult worms in his lymphatic system. The embryos seen in human blood are incapable of further development unless they are taken up by mosquitoes.

The embryos of *W. bancrofti* throughout the countries in which this worm is found (except certain islands of the Pacific), and those of *W. malayi*, exhibit the remarkable phenomenon of periodicity in the blood of man; that is, the embryos are found in the blood in large numbers at night, but in very small numbers in the daytime. The explanation of this peculiarity is still the subject of debate, but whatever the explanation, the fact of periodicity remains, and this periodicity is curiously adapted to the habits of the mosquitoes which are essential to the transmission of this infection from one person to another, for the mosquitoes concerned bite chiefly at night when the embryos are most plentiful in the blood.

In the Pacific islands east of longitude 170° E. the embryos of

W. bancrofti do not exhibit periodicity, but are present in the blood in equal numbers by day and night. In these islands the mosquito responsible for transmission (*Aëdes pseudoscutellaris*) feeds largely by day.

Transmission. *W. bancrofti* of the periodic variety is transmitted by mosquitoes of

pseudoscutellaris. These mosquitoes breed in collections of water of very diverse types, in cesspits and other foul waters (*Culex*) as well as in the cleaner waters favoured by *Anopheles* and *Aëdes*. The vectors of *W. malayi*, however, form a very distinct group; these mosquitoes of the genus *Mansonia* are peculiar in that their larvae, living, as usual, in water, obtain their oxygen, not by rising to the surface of the water and breathing through their spiracles, but from certain water plants, into whose roots the larvae insert their breathing tubes. These mosquitoes cannot breed in the absence of these water plants, and each species of *Mansonia* has its own preference in water plants. Removal of the relevant plants, therefore, suppresses the breeding of these mosquitoes

Symptoms. Infection with these filarial worms may not give rise to any symptoms, or may lead only to mild attacks of lymphangitis (inflammation of the lymphatic vessels of the limbs) or of inflammation in the tissues connected with the testicles. These attacks of inflammation are usually accompanied by fever. The adult worms, however, which live in the lymphatic glands, tend to set up irritation in those glands, causing proliferation of tissue which eventually obstructs the flow of lymph through them. If this obstruction is extensive, the damming up of the lymph causes extensive changes in the limb beyond the point of obstruction, and the final result is that slow, painless swelling known as elephantiasis. In severe cases of elephantiasis the legs, scrotum, or arms may be enormously enlarged, and the disability to the patient may be very great.

The reader should understand that there are many other manifestations of elephantiasis, too numerous to give in detail here, and that most of them involve swelling of some part of the body. He should also understand that the simple mechanical view of obstruction of lymphatic channels is not the whole explanation of the process; mechanical factors in living tissues cause biological

changes in the living cells, which are subject to more complica[ted] laws than those which govern non-living matter.

It appears to be true that only patients who have repeatedly be[en] infected are likely to develop elephantiasis, and that of those r[e]peatedly infected, only a proportion, in fact, do develop the condi[tion]. The indigenous peoples of some of the countries in whic[h] filariasis occurs are subject to frequent infection from infancy on[wards], yet the proportion with obvious elephantiasis may not be large.

Treatment. There is no drug yet known which can be relied upon to rid a patient of these worms, though research to discover such a drug is being pursued and some promising results have recently been achieved with the drug Hetrazan. Filarial fever should be treated by rest in bed, and lymphangitis by rest and support to the inflamed part. The enlarged scrotum of elephantiasis can successfully be removed by surgical operation, and surgery may give some relief in elephantiasis of other parts of the body, but these surgical measures are only palliative.

Prevention. Suppression of mosquito breeding is an obvious measure of prevention, and for this to be successful the breeding habits of the incriminated mosquitoes should be studied. For those (*Mansonia*) whose larvae live in association with water plants, removal of these plants is effective; the water-lettuce (*Pistia stratiotes*) is a case in point, it promotes the breeding of *Mansonia annulifera*, the vector of *W. malayi* in Travancore, and its removal has been very successful in reducing the disease in that area.

In addition to suppressing the breeding of mosquitoes, officers should take all the usual personal precautions against being bitten by mosquitoes, which are given elsewhere in this book.

Loa loa

This filarial worm affects man in West and Central Africa. [The] adult worms are hair-like, and live in the connective and o[ther] tissues of the human body, in which they migrate extensively. [The] females produce embryos which are found in the blood, and w[hich] show periodicity the reverse of that shown by *W. bancrof[ti]* [and] *W. malayi*, in that the embryos of *L. loa* are found in the [blood in th]e daytime but not at night.

This infection is transmitted from man to man by [flie]s of the genus *Chrysops*.

L. loa does not cause elephantiasis, but is responsible for Calabar swellings, transient subcutaneous swellings which subside spontaneously, doing little or no permanent harm. The worm may cause trouble by invading the conjunctiva of the eye. Drug treatment with Hetrazan is of value, but prevention is largely impossible.

Onchocerca volvulus

This filarial worm is found in man in East, West, and Central Africa, and in Central America.

The worms, male and female, form nodules beneath the skin of man, and the embryos they produce inhabit the tissue spaces in the neighbourhood of these nodules. They are picked up by biting flies of the genus *Simulium* (black flies), and, after a period of several days, during which the embryos undergo a cycle of development in the flies, are transferred to man by these flies when the flies attack new hosts

These flies breed in association with running water, and their larvae are attached to stones in the streams; the adult flies live within a short distance of these streams, and the disease therefore is found in the neighbourhood of running water.

Symptoms. The nodules themselves may be troublesome, but are not, as a rule, of serious importance Embryos from nodules on the face, or even when no nodules can be found, may invade the tissues of the eye, and may seriously affect the sight, sometimes even leading to what is known as filarial blinding. Skin troubles of various kinds are also associated with this infection.

Treatment is by Hetrazan and surgical removal of the nodules, but prevention is not easy. African villages situated some little distance from streams are less affected by this disease than those on the banks, and a possible method of prevention might consist of removing settlements to a distance of half a mile or more from the water. The use of DDT in streams has proved most effective in killing the larvae of *Simulium*, in one experiment in Kenya, and this method of control will, no doubt, be widely used.

Other filarial infections are found in man in various tropical countries, but they are so harmless that no description of them need be given.

SECTION 3

OTHER DISEASES

CHAPTER XIV

TROPICAL ULCER

ROPICAL ulcer, usually affecting the leg below the knees, is one ' the most common diseases of all tropical countries.

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Symptoms. The ulcer usually starts near the ankle, and within few days spreads to cover an area the size of a half-crown, or nore The edge is raised, the floor of the ulcer is raw and bleeding, r may be covered by a greyish slough, there is usually a foul smell, nd the ulcer is extremely painful If not treated effectively it may pread widely and deeply, eating into muscles, down to bone, and estroying the tissues to such an extent that the only effective reatment is amputation of the limb

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Treatment. *The chief need is rest of the affected limb*, and this can be satisfactorily obtained only by placing it in splints, and the patient in bed. The ulcer may be scraped (under anaesthesia) and dressed with antiseptics, such as potassium permanganate, or the patient may be treated with penicillin. Dressings may with advantage be covered completely with adhesive plaster. Whatever the local treatment, the patient should be given a liberal diet which contains fresh fruit and vegetables, fresh milk if possible, and some oily source of vitamins A and D, such as cod-liver oil or red palm oil.

Prevention. The diet should be adequate in quality and quantity. Even trivial injuries of the skin of the feet and legs should at once *be cleaned, treated with iodine, and covered with some occlusive* dressing such as 'Elastoplast', or adhesive strapping over sterile gauze. If this is made a matter of discipline in labourers on plantations, who run considerable risk from these small accidents, the incidence of ulcer will not be high. Such disciplinary measures have been popular with employers, because they undoubtedly prevent much absence from work due to these disabling ulcers. They are also, obviously, desirable in the interests of the men themselves. For the general population, to advocate immediate treatment of small injuries is as yet a counsel of perfection. Education will do something to prevent the disease, and the stimulation of good agriculture will help by offering to the people a reasonable diet. Cleanliness of the skin is also probably a factor in prevention.

But it must be confessed that tropical ulcer remains a baffling problem, not fully understood.

CHAPTER XV

SKIN DISEASES

THERE are many forms of skin disease, and many causes; only a few need be discussed, for most skin diseases require expert diagnosis and treatment, and fall outside the scope of this book. Officers may, however, see (or suffer from) certain groups of skin affections for which they can give simple but useful treatment, and the medicaments needed are not too elaborate to be included in an ordinary medicine chest.

Several diseases are the result of inflammation of the skin, the causes of which may be physical (the action of the sun), chemical (in the handling of certain substances used in industry, or contact with certain plants), bacterial (in boils or impetigo), or parasitic (insects, &c.).

Sunburn may be painful if exposure is made too quickly to the direct rays of the sun, as when shorts are worn for the first time. Prevention is obvious.

Apart from sunburn, hot atmospheric conditions affect the skin by causing excessive and continuous sweating The condition known as *prickly heat* is the result of sweating, and is particularly common where the atmosphere, besides being hot, is humid, and where sweat does not quickly evaporate. The skin in such a climate tends to be constantly wet beneath the clothes, though on exposed surfaces it dries more effectively; in some people the skin reacts by becoming inflamed. The sweat glands are over-active and there is a tendency for their ducts to become blocked, with the result that small swellings appear in the skin. These may go on to the formation of minute blisters, and the blisters may become infected by bacteria, forming boils. The skin is irritable, and there may be a sensation of itching (from which the disease derives its name), or even severe pain. Prickly heat is not an infective disease. It occurs in only a minority of people, whose skins are susceptible to it, and in these persons it is found during the hot season, and affects those parts of the body where there is little exposure to the air—the arm-pits, groins, round the waist—though it is sometimes widespread.

Treatment is not easy Every effort should be made to avoid

Treatment. The chief need is rest of the affected limb, and this can be satisfactorily obtained only by placing it in splints, and the patient in bed. The ulcer may be scraped (under anaesthesia) and dressed with antiseptics, such as potassium permanganate, or the patient may be treated with penicillin. Dressings may with advantage be covered completely with adhesive plaster. Whatever the local treatment, the patient should be given a liberal diet which *contains fresh fruit* and *vegetables, fresh milk if possible*, and some oily source of vitamins A and D, such as cod-liver oil or red palm oil.

Prevention. The diet should be adequate in quality and quantity. Even trivial injuries of the skin of the feet and legs should at once be cleaned, treated with iodine, and covered with some occlusive dressing such as 'Elastoplast', or adhesive strapping over sterile gauze. If this is made a matter of discipline in labourers on plantations, who run considerable risk from these small accidents, the incidence of ulcer will not be high. Such disciplinary measures have been popular with employers, because they undoubtedly prevent much absence from work due to these disabling ulcers. They *are also, obviously, desirable in the interests of the men themselves.* For the general population, to advocate immediate treatment of small injuries is as yet a counsel of perfection. Education will do something to prevent the disease, and the stimulation of good agriculture will help by offering to the people a reasonable diet. Cleanliness of the skin is also probably a factor in prevention.

But it must be confessed that tropical ulcer remains a baffling problem, not fully understood

CHAPTER XV

SKIN DISEASES

THERE are many forms of skin disease, and many causes; only a few need be discussed, for most skin diseases require expert diagnosis and treatment, and fall outside the scope of this book Officers may, however, see (or suffer from) certain groups of skin affections for which they can give simple but useful treatment, and the medicaments needed are not too elaborate to be included in an ordinary medicine chest.

Several diseases are the result of inflammation of the skin, the causes of which may be physical (the action of the sun), chemical (in the handling of certain substances used in industry, or contact with certain plants), bacterial (in boils or impetigo), or parasitic (insects, &c.).

Sunburn may be painful if exposure is made too quickly to the direct rays of the sun, as when shorts are worn for the first time. Prevention is obvious.

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tends to be constantly wet beneath the clothes, though on exposed surfaces it dries more effectively, in some people the skin reacts by becoming inflamed The sweat glands are over-active and there is a tendency for their ducts to become blocked, with the result that small swellings appear in the skin. These may go on to the formation of minute blisters, and the blisters may become infected by bacteria, forming boils. The skin is irritable, and there may be a sensation of itching (from which the disease derives its name), or even severe pain Prickly heat is not an infective disease. It occurs in only a minority of people, whose skins are susceptible to it, and in these persons it is found during the hot season, and affects those parts of the body where there is little exposure to the air—the arm-pits, groins, round the waist—though it is sometimes widespread

Treatment is not easy. Every effort should be made to avoid

sweating, by reducing clothing and limiting bodily activity during the hottest hours of the day. All garments should be scrupulously clean, and should be changed frequently. A towel should be used freely and constantly to mop up sweat. The clothes should admit as much air to the skin as possible, but in the evenings this rule must be balanced against the danger of mosquito bites. Tepid baths may be taken morning and evening, but the skin must be carefully (though not vigorously) dried. A powder containing equal parts of zinc oxide, starch, boric acid, and sulphur (of which the last is the most important ingredient) may with advantage be dusted on the dry skin after bathing. If boils occur medical advice should be sought; it is unwise to treat a sensitive skin with fomentations or sulphonamide ointment, which may lead to conditions worse than the original disease. In modern skin practice the use of sulphonamide creams and ointments has been abandoned because experience has shown that they too frequently lead to severe and intractable dermatitis.

At one time it was thought that diet had some part in the causation of prickly heat, and patients were warned to avoid highly spiced foods and to ensure intake of a sufficient amount of vitamins This is still good advice, though the actual effect of injudicious diet is doubtful; it is always wise to be correctly fed. The advice sometimes given to reduce consumption of fluid so as to reduce the amount of sweat produced should be received with scepticism; it may be dangerous to reduce fluid intake unduly in a climate in which sweating is necessary to keep the body temperature normal

In intractable cases of prickly heat the patient should be sent to a different climate. Change to a hot but dry atmosphere clears up the skin condition in many cases, and change to a temperate climate almost always does so It is usually true that the rate of improvement in patients who continue to live in the same climatic conditions which brought on the affection is slow; but, of course, seasonal changes often bring relief.

Chemical irritation may arise from contact with a wide variety of substances Some wood-workers, for instance, have dermatitis (inflammation of the skin) if they handle certain woods, though others may be innocuous to them; fruit and flowers may have a similar effect, and the chemicals (especially organic compounds) used in industry have strong action on sensitive skin. But susceptibility to the action of these irritants is by no means universal; some

people can handle them with impunity whereas others (usually a minority) are adversely affected. Forms of nettle-rash (urticaria) which may be due to internal affections (such as the intestinal worms) or external irritants (such as various plants) are rather more common in the tropics than in cool climates. Hay-fever (though not a skin affection) has affinities with nettle-rash, and is not rare in the tropics It is due to the pollen of plants acting on the sensitive mucous membrane of the nose and air passages.

Bacterial infections of the skin have been referred to above They are particularly found in persons subject to prickly heat or to a form of acne ('blackheads') which is due to blockage of the mouths of the sebaceous glands of the skin These glands secrete a fatty material on to the surface of the skin. The acne was common in British troops serving in hot climates during the recent war, and affected those parts of the body on which webbing equipment exerted most pressure Apart from maintaining the skin in as clean and dry a state as possible, officers should not attempt treatment of this condition, but should seek medical advice

Other common diseases due to bacteria are boils, carbuncles, and impetigo Boils are the result of infection of the roots of hairs, and carbuncles are similar but much more extensive and serious Both boils and carbuncles are seen in people whose general resistance is lowered, and the discharge from one boil may infect neighbouring hair roots, to produce a series of boils in successive crops Small pimples, and even boils, often arise in hair roots which are plugged by the sebaceous material described above

Impetigo is an acute condition of the skin, common in children, which shows as a crusted eruption, often on the face It is not usually serious, but is very infective. It is not common in the tropics.

Boils may be left to take their own course, if they are not large, or they may be fomented A hot fomentation is made by placing a piece of boric lint, wrapped in a hand towel, in hot water for a few minutes, wringing it out by twisting the towel until it is almost

should be repeated three or four times during the course of one hour, once or twice a day. The fomentation should not be left on indefinitely, for it will make the skin damp, soggy, and unhealthy.

and may even spread the infection. Severe boils and carbuncles may need surgical operation or penicillin injections, and a succession of boils is an indication for medical advice. General treatment such as a holiday in a cool climate, and a change of diet, may be the best course to adopt in a case of a succession of boils, and a vaccine may help towards cure.

Impetigo should be treated by bathing the affected skin in warm water, to remove the crusts, and then by applying potassium permanganate solution, 1 in 8,000 (1 grain of permanganate in 1 pint of water is 1 in 9,600; small tablets of permanganate, each weighing one grain, can be obtained and are useful). Officers should not attempt treatment with the stronger preparations sometimes used by medical men, because there is a very real and serious risk that they may set up severe dermatitis unless used with circumspection, and for careful use medical training and experience are necessary. In particular, officers should not use sulphonamide drugs on the skin, either as powders, ointments, or solutions, because the skin easily becomes very susceptible to them. The same is true of penicillin. These substances should be administered either by the mouth or by injection

Skin diseases due to fungi are largely of the ringworm type (the word is a misnomer in that no worm is involved), of the scalp or of the skin of the body and limbs. These diseases are fairly common in the tropics, and in Europeans may affect the groins, the inner sides of the thighs (so-called dhobie itch), or the skin between the toes (athlete's foot) Any skin affection should be shown to a medical officer, so that a correct diagnosis can be made, but for the *simple fungus diseases treatment with Whitfield's ointment* (3 per cent. salicylic acid, 5 per cent. benzoic acid, in paraffin or in paraffin and coco-nut oil), or ointment of 5 per cent. undecylenic acid, is usually effective. But medical advice should be sought, both for correct diagnosis and for appropriate treatment; Whitfield's ointment should be used only under medical supervision.

Athlete's foot is an infective fungus disease, transferred under conditions where people walk barefoot, for instance round swimming-baths, and in the dressing-rooms of sports buildings. The fungi may persist in shoes worn by the patient. Athlete's foot may be very troublesome, and needs expert attention. In the absence of medical advice the feet should be *kept scrupulously clean and dry*; a bland powder (talcum) may be dusted on them after they have

been thoroughly dried. Half-strength Whitfield's ointment may be applied from time to time.

Parasitic diseases of the skin are common in the tropics, but are usually easily avoided. Leeches are troublesome in some countries, ticks and larval mites in others; the skin where they have attached themselves may become infected by bacteria, and this may give rise to troublesome sores or ulcers Leeches do not convey disease to man, but ticks and larval mites do if they themselves are infected, for instance with fevers of the typhus group. Care should be taken that leeches do not gain access to the nose or mouth, as may happen while bathing in leech-infested water, or drinking it; if they do, they may attach themselves in the nasal passages, and create much trouble. The bites of leeches are often painless, and the bitten person may not know that a leech is attached. Leeches may be dislodged by applying vinegar or salt to them, or by touching them with a lighted cigarette. Dimethyl phthalate, which is extremely useful as a repellant against mosquitoes and other biting insects, is also very effective against leeches.

Certain flies deposit their eggs on the surface of wounds, or in the nasal passages of cattle, sheep, and man; others deposit them on the ground, and the larvae (maggots) which develop from these eggs are attracted to man or animals who rest on that spot. The maggots of these various flies may penetrate the skin and develop beneath it, giving rise to troublesome, painful swellings which may become infected by bacteria, like boils Larvae deposited in the nasal passages bore their way into the mucous membranes lining [illegible] the dust of the floor when it has finished its meal.

Prevention of these fly-maggot infections is not easy in cattle-keeping communities, but human infection is not, in fact, common. Treatment is best left to a medical man if the maggot cannot be expelled from the skin by moderate pressure

Another insect which burrows into the skin is the chigger (*Tunga penetrans*) This is a species of flea, often present in the earth of house floors; the female, after being impregnated, attaches herself to the skin (usually of the feet) and burrows into it There the chigger matures her eggs, swelling to many times her original size. At this stage the chigger forms a swelling about the size of a small

pea, and during the process of development it causes an itching, burning sensation which is an exasperating nuisance. The chigger can be extracted with a needle (previously sterilized); Africans are usually *expert at this little operation. Nevertheless, septic infection* may occur and cause more severe trouble if the extraction is not carefully done; iodine and a dressing should be applied when the operation is finished. Prevention is a *matter of protecting the feet.* Officers should not walk barefoot in their houses, and they should shake out their shoes and slippers before putting them on, a precaution which is also to be recommended as a protection against spiders, scorpions, and other small animals with offensive habits.

Other fleas are common in the tropics, especially in grain stores and other haunts of rats, and in human dwellings Flea bites, like mosquito bites, may cause such itching that the skin is abraded by scratching, and may become septic. Fleas are important as transmitters of plague and one form of typhus.

Body lice are also fairly common in some hot countries, but [illegible] amount of clothing [illegible] from person to person during sexual contact. All these lice may cause inflammation of the skin by their bites. Prevention of louse infestation is a matter of cleanliness, but if it does occur, DDT powder will destroy the lice (but not their eggs) and should be applied beneath the clothing at a strength of 5 per cent. in talcum powder *If the eggs are to be destroyed in clothing, or if the louse* faeces are suspected to contain the rickettsiae of typhus (which is the case with lice which have bitten a patient with that disease), *heat must be applied to the garments*; they should be boiled, or steamed in an approved type of container, for instance the 'Serbian barrel'. Steam is led by a pipe to the top of this barrel, in which the clothes are lightly packed, and forces its way downwards, to escape [illegible] all parts of the garments and [illegible]

[illegible] *scabiei*, a minute arthropod which bores into the skin and lives there, especially between the fingers, causing the irritation from which the disease is named. Scabies is not uncommon in the tropics, and may give rise to extensive skin trouble from secondary bacterial infection. It is transmitted from person to person by direct contact.

Scabies is best treated by local application of benzyl benzoate, but a more generally available remedy is sulphur ointment, which should be applied after the affected skin has been scrubbed with soap and water. Sulphur may cause dermatitis, and benzyl benzoate is safer.

Scabies is acquired by direct contact with an infected person, or, more doubtfully, with his clothing; it is not likely to be seen in Europeans, but causes much trouble in the indigenous people, especially children, of some countries.

Certain worms, whose larvae penetrate the human skin (hookworms and schistosomes) cause transient skin rashes, but there is no specific treatment for the rashes themselves, prevention has been referred to in the chapter on diseases due to worms. The larvae of the dog and cat hookworm (*Ancylostoma braziliense*) bore their way into the skin of those who come into contact with them. Unlike the larvae of the human hookworms these do not pass through the skin, but move in it, leaving a track which can often be seen, and which may become infected by bacteria. The patient suffers considerable irritation and pain. The condition is known as *larva migrans* or creeping eruption, and treatment is usually a matter for a doctor. This is a rare affection, and is not serious, but it may affect children who play in sand contaminated by the faeces of dogs.

Various other forms of skin disease may be seen in the people of tropical countries, and officers may be asked to give treatment for them. But the proper treatment of skin affections demands great skill in diagnosis and judgement in prescribing, for wrong treatment can be disastrous, either by failing to influence the disease or by damaging an already tender skin. No easy advice can be given. Only a few of the commoner skin diseases are mentioned here.

CHAPTER XVI

SNAKE-BITE AND ATTACKS BY OTHER ANIMALS

POISONOUS snakes are found in most tropical countries, but as a rule there are many more non-poisonous than poisonous species.

The poison is formed in glands which are probably modified salivary glands, and when the snake bites, the poison is ejected through hollows or grooves in the two large fangs which are connected with the glands. These fangs may be situated towards the front of the mouth, and may be long and retractable, so that they can be folded away when the mouth is shut. Snakes with fangs of this kind are usually dangerous; the long hollow fangs (attached to the upper jaw) cause relatively severe wounds and enable the venom to be injected deeply into the tissues. Other snakes have fangs situated farther back on the upper jaw, and these are short, not retractable, and grooved. Such fangs give slighter wounds, and much of the venom is lost because the grooves do not conduct it all into the wounds

The poisons themselves are complex fluids having several distinct effects, but in general they fall into two groups, those which affect chiefly the nervous system of the bitten animal, and those whose effect is predominantly on the tissues in the immediate neighbourhood of the bite The venom of snakes of the cobra group (cobra, krait, mamba, &c.) usually acts chiefly on the nervous system; that of the viper-rattlesnake group (Russell's viper [daboia], phoorsa, fer-de-lance, &c.) usually causes a local effect round the wound. Each of these two types of venom may cause death or very severe illness, if the snake injects a considerable quantity. It is a help to the doctor if the snake can be killed at the time of the bite, and shown to him, so that he may have early indication of the probable effect of the bite and plan his treatment accordingly.

Symptoms of bites by snakes of the cobra group are sometimes slow to appear, especially if the bite is on the leg There is little pain at the site of the bite, and the severe general effect may be delayed for 24 or even 48 hours The condition of the patient in the early hours, therefore, is not necessarily a good guide to the later effects. The patient may suffer from nausea and may salivate profusely and vomit; in severe cases paralysis occurs, of the tongue,

larynx, or of the muscles of respiration, and the patient is likely to die. In milder cases the symptoms are less severe, and recovery is quite rapid.

Symptoms of bites by snakes of the viper-rattlesnake group appear quickly, at and round the site of the bite The bitten part is extremely painful and swollen, with haemorrhage beneath the skin for some distance round the bite, and blood-stained discharge These local effects spread rapidly, and more general symptoms (collapse, with loss of consciousness) may arise as the venom spreads in the blood-stream If the patient recovers from the immediate effects, he usually experiences severe trouble round the bitten part for days or weeks afterwards. The local action of the venom destroys the tissues near the bite, and causes haemorrhage Bacteria from the skin or the soil (or from the mouth of the snake) gain access to this dead tissue and blood clot, and they multiply freely, causing abscess formation and further destruction of tissue. This septic infection may be so severe as to necessitate amputation of the limb, or even to kill the patient days or weeks after the bite.

Non-poisonous snakes sometimes bite, and in such cases the marks of rows of teeth may be seen, but without the characteristic large punctures of two fangs, which are typical of the poisonous snakes.

Treatment of snake-bite entails first the removal of as much of the venom as possible from the wound. The patient should be kept quiet. If the bite is on arm or leg a tourniquet should be applied above the wound, but not so tight that the pulse is stopped. If the proper tightness cannot be estimated the tourniquet should be loosened completely for 2 or 3 minutes every quarter of an hour. (Readers should remember that a tight tourniquet is a most dangerous instrument, which is capable of doing irreparable injury; it should be used only with the greatest caution.) The attendant should then, with a sharp and sterile knife or razor blade, make a fairly deep criss-cross incision through the fang marks, to cause fairly profuse bleeding, and should make a series of smaller incisions round the bite and 2 or 3 inches from it, also to cause bleeding. The object is to wash out the venom with the blood, and thus to prevent it from gaining access to the rest of the body. Suction may also be applied, even by the mouth (preferably after placing a thin sheet of rubber over the wound and applying suction through it). The venom will not affect the undamaged mucous

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Symptoms of bites by snakes of the cobra group are sometimes slow to appear, especially if the bite is on the leg. There is little pain at the site of the bite, and the severe general effect may be delayed for 24 or even 48 hours. The condition of the patient in the early hours, therefore, is not necessarily a good guide to the later effects. The patient may suffer from nausea and may salivate profusely and vomit; in severe cases paralysis occurs, of the tongue,

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membrane of the mouth, and should be spat out. These measures should be kept up for several hours, if necessary.

The use of potassium permanganate, to rub into the snake-bite, is not now advised. It has little or no effect on the venom (which it usually does not reach) but can seriously harm the tissues. The wounds may be bathed in sterile water. The patient should be given fluids to drink, coffee, tea, and water are useful for this purpose, but whisky is said to be harmful.

The patient should, of course, be carried to a doctor as soon as possible, and the snake should be preserved (though this is rarely possible). The doctor may be able to inject a serum which may greatly modify the effects of the venom, but a serum prepared against one group of snakes may be relatively impotent against venom from a snake of the other group.

In Africa certain cobras spit their venom, and if it reaches the eyes of the victim it causes intense irritation which may lead to blindness. The eyes should be washed out at once, and repeatedly, with water.

To recognize snakes of the two main groups is not easy. Many of the poisonous species have relatively large triangular heads, thick bodies and stumpy tails, but some are small and whip-like. The presence of the two large fangs in the upper jaw indicates a dangerous snake.

Snakes are not usually aggressive unless disturbed, and even then they tend rather to escape than to attack; but they should be treated with respect. They are usually active at night, but may be disturbed by man's activities in the day-time. As a rule, serious encounters with snakes are very rare.

Other venomous animals include scorpions, which sting with their tails. They are common in North Africa, Central America, &c., and may be found under stones, and in other covered spots; they may enter tents and houses. The sting is intensely painful and the venom has an action on the nervous system somewhat like that

to bleed freely, and should be washed out with sterile water. A serum has been prepared in French North Africa which is very useful, but it is rarely available in remote stations elsewhere.

Certain spiders cause trouble by their bites, the most notorious

being the black widow spider, but the damage is usually local and the spiders are not dangerous to life except in very rare cases. Again, the wound may be incised and washed out, to eliminate the venom

Bites or other wounds caused by large animals—lion, leopard, buffalo, crocodile, &c —may be dangerous from the damage they cause in themselves, or by the bacterial infection which attacks the damaged tissues. The lion, for instance, is a dirty eater; its mouth and teeth are always heavily contaminated from the entrails of its victims, and as its teeth penetrate human flesh they introduce at the same time the bacteria which will later cause the wound to become septic. The same is true of its claws, and of the teeth, claws, and horns of other animals. The tetanus bacillus and the organisms of gas gangrene live in soil contaminated by animal faeces, and in the intestine of large animals; they are often present on the feet, claws, and horns of these animals, and may enter wounds made by these weapons, or they may contaminate the wounds of men who lie on the ground after being attacked In warfare, tetanus and gas gangrene are most serious complications of wounds, and are usually acquired from contamination with infected earth or faeces The same is true of wounds made by animals, and these should therefore never be treated lightly. Medical aid should be sought

CHAPTER XVII

FOOD DEFICIENCY DISEASES

DEFICIENCY of food may be quantitative, when the total amount is short of human need, as in famine; or qualitative, when some component is lacking, although the total amount is adequate. Famine is common enough in tropical countries, and if drought occurs, or locusts devastate the crops, the administrative officer may well find himself faced with a most serious shortage of food, affecting a large population. The people will turn to him for relief, and it is obviously one of his more important duties to make himself constantly aware of the crops cultivated in his district, and of the effects on them of unfavourable weather. Some crops, of course, are more susceptible to drought than others, and the administrative officer in a country in which famine due to drought is possible, would be wise to consult with the agricultural department as to the best food crops to cultivate in view of undependable weather, and to urge the people to mix their crops so that if drought occurs the results may at least be mitigated. But in any consideration of food crops the advice of experts in human nutrition must be sought; neither the agricultural nor the administrative officer is competent to decide which foods are optimum for human needs.

As a rule, the administrative officer will be aware of famine from other sources than patients suffering from under-nourishment, but where the deficiency of food is qualitative rather than quantitative he may see people suffering from deficiency diseases. If he does so he should realize that these diseases, though they can often be cured in the individual patients, can be prevented, not by medical action, but only by a reorganization of agricultural habits which may involve social and industrial changes of the most far-reaching kind. For instance, if a high proportion of young adult males leave the district for work as miners which may keep them away for a year or more, the agricultural work devolves upon the women, who may be unable to sustain it. In that case the tendency will be to cultivate the easiest crop, which may have poor nutritional value,

the mere advice that a more varied and nutritious diet must be provided by more efficient agriculture. In theory, the money earned by the young men should enable them to buy the nutriments needed by their families; in practice this does not, by any means, always happen The men often [illegible] or are deprived [illegible] oth[illegible] The land in t[illegible] deforested, overstocked with unus[illegible] eroded, and turned into unproductive desert, and this tendency calls for action which covers all phases of government

Foodstuffs

Certain constituents are necessary for an adequate human diet.

Protein is contained in meat, eggs, fish, and other animal tissues, and also (but in smaller proportion) in vegetables, especially beans and peas. It is necessary for building up and maintaining the body tissues.

Fat is needed, not only for its own sake, but because some fats contain essential vitamins

Carbohydrate is the starchy element of food, and forms the great part, for instance, of such universal foods as rice, wheat and other flour, potatoes and other vegetables. Carbohydrate provides most of the energy for the day-to-day activities of the body, and is the easiest component of food to provide. The diet of most people in tropical countries contains an adequate amount of carbohydrate, but inadequate amounts of protein and fat.

Salts are needed, but are usually found in adequate amounts in the natural foods A deficiency of iodine in the soil, and therefore in the food, is responsible for the goitre found in some parts of the world. A shortage of iron may occur if the diet does not include enough green vegetables.

Vitamins. These essential constituents are of the greatest importance, but, although they have been extensively studied, they are as yet imperfectly understood, nor is it likely that they have yet all been isolated They are divided into two main groups the fat-soluble vitamins (A, D, and E) which are present in animal fats and oils, and in some vegetable oils; and the water-soluble vitamins (the B group, and C) which are found in animal tissues, in the germ of wheat, rice, and other cereals, in fruits and vegetables. The list of known vitamins is now very long. Man must receive his supplies

chiefly in his food, since although the bacteria which normally inhabit the human intestine (harmlessly) can probably manufacture some of them, to be absorbed and used by man, these are few, and man cannot manufacture the other vitamins for himself.

The constituents mentioned are all present in the normal mixed diet taken by most families in Britain, which includes meat, vegetables, fruit, bread, butter, milk, and other items, in reasonable quantities, and under such conditions it is perfectly safe to allow the natural appetite and general health to dictate the amount and variety of food taken. But where variety is difficult there may be danger of a lack of balance in the diet, and deficiency in certain constituents. In such a case, if the deficiency is known, it should be corrected, if possible, by obtaining the natural foods which contain the lacking constituent. For instance, if the diet contains too little vitamin C, steps should be taken to secure fresh fruit such as lemons or oranges, rather than supplies of vitamin capsules. The study of vitamins is as yet hardly so advanced that we can be sure that the vitamins prepared in laboratories contain all the relevant substances contained in the natural foods. Thus, although artificially prepared vitamins have undoubted value under certain conditions, it is wise to take a full mixed diet which provides all the vitamins in the natural state, rather than to make a practice of taking artificial or synthetic preparations.

For the people of tropical countries, of course, there is no question; their supply of necessary constituents of diet, including vitamins, must be derived from their everyday food, and in the conditions under which they live it is unfortunately often true that the first consideration is to satisfy hunger, and that the only way known to them of doing so is by cultivation of crops rich in carbohydrate but poor in all the other essentials. A diet which consists almost exclusively of maize or rice may be eaten because the people do not understand the fundamental changes they must make in their systems of agriculture and animal husbandry which would lead to such fertility of soil that good mixed farming would be possible.

Famine oedema

Famine oedema (a form of dropsy) is due to insufficient intake of food, especially of protein. The patient is emaciated, but this emaciation is concealed by the oedema, which is a condition in which fluid collects in the tissues in abnormal quantities. The fluid

tends to accumulate in the legs and dependent parts, or in the arms and face, or in the abdominal cavity. The appearance, therefore, is of a patient with bloated face, protruding abdomen, and swollen legs and ankles, but, on careful inspection, the emaciation is apparent about the ribs, the shoulders and arms, the neck and the thighs. The patient is very weak and anaemic, and usually suffers from diarrhoea. Many cases were seen in the concentration camps of Europe at the end of the recent war, and in India during the [illegible]

in spite of the most careful treatment. Even in cases in which cure is possible it is often difficult. Treatment is essentially a matter of restoration to full diet, but this must be done slowly, since over-rapid feeding may precipitate dangerous intestinal derangement Milk is invaluable in this respect Rest is also essential, and good nursing People reduced to this extremity of distress have usually undergone severe physical and mental trials, and have usually been exposed to infective diseases—typhus, cholera, malaria, and the like—which need treatment. Moreover, deficient nutrition so reduces resistance to tuberculosis that this disease is a common concomitant of malnutrition throughout the world.

Cirrhosis of the Liver

There is good evidence that certain forms of cirrhosis of the liver in children are due to deficiency of protein substances in the diet (see kwashiorkor, below). A child with this condition has an enlarged liver, and therefore a somewhat prominent abdomen, and may have a collection of fluid in the abdomen; he is usually rather thin. The occurrence of cases of this condition is to some extent an index of the standard of nutrition of the community, but the diagnosis needs skill and experience

Vitamin Deficiency Diseases

Deficiency of certain of the vitamins leads to well-recognized and clear-cut diseases, but deficiency of others is not so easily detected. To produce these clear-cut diseases deficiency of the relevant [illegible]

are very vague. There may, in fact, be no more than indefinite ill health, with some slight loss of weight and loss of vigour. It is difficult to prove that such slight manifestations are due to lack of *any particular constituent of food*, but that they are probably the result of dietary deficiencies, and can be cured by a balanced and varied diet known to contain all the essentials in requisite amounts, is generally accepted.

Vitamin A has an action in helping the body to combat the agents of infective diseases, but apart from a certain condition of the eye no gross disease is specifically associated with lack of this vitamin.

Vitamins of the B group are very numerous; deficiency of B_1 (thiamin, aneurin) is the cause of the disease beriberi, which, in the past, has caused an enormous amount of ill health among the *rice-eating peoples of the Far East; deficiency of nicotinic acid* (niacin) is associated with pellagra, a notorious disease found chiefly in those whose diet consists too largely of maize; deficiency of riboflavin causes the combination of symptoms known by the clumsy name ariboflavinosis. Deficiency of vitamin C is the cause of scurvy, and deficiency of vitamin D is associated with rickets Vitamin E affects fertility, and lack of it has been held in part responsible for low birth rates

The chief deficiency diseases may with advantage be described.

Beriberi

Cause. *Deficiency of vitamin* B_1. This vitamin is found in the pericarp and germ of cereals, in yeast, pork, pulses, and vegetables. Beriberi is particularly prevalent in people whose staple diet is milled or polished rice. The whole rice grain consists of three chief parts. the husk, the germ and pericarp, and the starch. *In preparing* this grain for food the fibrous husk must be removed, and this can be done by quite primitive means. The grain left after this [illegible] in colour, because the germ and peri- [illegible]

is a delicate covering of the whole grain. Vitamin B_1 is present in the germ and pericarp. Rice as it is usually seen is white, and its appearance is clean and attractive. This is because modern methods of milling are much more rigorous than primitive methods, and remove not only the husk but also the germ and pericarp, leaving

nothing but the starch. This process is known as polishing, and it is this polished rice, which attracts the eye, and which keeps well, that has been responsible for beriberi, for in the process of polishing the vitamins are removed, and some of the rice eaters of the Far East do not make up their supplies from other foods.

Symptoms. Beriberi occurs in two chief forms, known as wet and dry. The wet form is a kind of dropsy, in which the legs, body, arms, and face may be swollen with fluid. In the dry form this dropsy is not present. In both forms the nerves of the limbs may be diseased and paralysis may occur, and in both forms the heart is affected, and death may take place from heart failure There are, of course, many other causes of dropsy and paralysis and heart disease, so that the diagnosis of beriberi is not always easy, but if an outbreak of cases with these symptoms occurs in a rice-eating population the suspicion of beriberi should be aroused.

There is a form known as infantile beriberi, which occurs in babies, especially in the Pacific islands, and which causes many deaths. It is probably due to poverty of the mothers' milk in vitamin B_1, and the diet of the mothers is usually deficient in this vitamin. It can be cured and prevented by the use of partly fermented toddy made from the sap of the coco-nut spathe.

Treatment. Administration of vitamin B_1 by the mouth, or by injection into a vein, produces astonishingly good and dramatic results in patients whose disease has not progressed too far. By the mouth, yeast or Marmite may be given, for injection, special pre-

foods known to contain the vitamin, should be given freely.

Prevention. The only way to prevent beriberi is by consuming a diet which contains a sufficiency of vitamin B_1, and, since there is evidence that beriberi develops only when the food consists too largely of carbohydrate, an ample supply of other ingredients such as proteins and fats should be ensured. For the rice-eating peoples who have in the past been especially prone to this disease the use of polished rice should be discouraged, and they should, so far as possible, be induced to use 'red' rice, or parboiled rice, which has been husked but from which the vitamins have not been removed It is often difficult so to persuade them, for they imitate the habits of Europeans and the wealthy members of their own communities, who demand the white, polished, aesthetically pleasing but

dietetically imperfect grain. Yet rice which retains its germ is a good food. The general answer is mixed farming, a good mixed diet, without overmuch interference with these natural foods.

Pellagra

Cause. Pellagra is due to deficiency of nicotinic acid (niacin) in the diet, and is common in people who use maize as their staple food.

Symptoms. In the fully developed disease the patient suffers from: dermatitis, an itchy, rough, inflammation of the skin, which appears on those parts exposed to sunlight—the neck, the arms, and the legs; diarrhoea, chronic and of moderate severity; and dementia, a mental deterioration which may be severe and which may therefore prevent the patient from co-operating willingly in treatment. The patient is usually emaciated The tongue may be inflamed, and bright red in colour.

Treatment. Administration of nicotinic acid by the mouth produces dramatic cure in early stages of pellagra, but it is a powerful drug, with a strong action on the circulation, and must be given with circumspection. Daily doses up to 300 milligrammes, divided and given at intervals of several hours, may be administered. It should be remembered that pellagra is often associated with ariboflavinosis, and that treatment for this condition also is needed

In some cases the most prominent symptom is dementia, and sometimes the cause of this is not appreciated. In this case the patient may be confined to an asylum, and unless nicotinic acid is given may not recover normal mentality, even on a fairly good diet.

Prevention. Nicotinic acid is present in animal tissues, especially in liver, eggs, and some fishes, and in whole wheat and other whole cereals. Diet should therefore include meat or other sources of the vitamin. An ordinary mixed diet is safe. The association often noticed between pellagra and maize is not fully understood; maize contains some nicotinic acid, but it is possible that this is, for some obscure reason, not fully available.

Ariboflavinosis

Cause. As its name implies, this condition is due to deficiency of riboflavin (vitamin B_2) in the diet. Riboflavin is present in yeast, milk, liver, kidney, and leafy vegetables, but there is not much in grain.

Symptoms. The characteristic feature is the formation of cracks and fissures at the angles of the mouth, with soreness of the tongue, undue sensitiveness of the eyes to light, with constant irritation and production of tears, and a roughening of the skin of the arms, shoulders, and legs

Treatment. The essential part of treatment is to administer riboflavin (of which an adult needs about 600 units daily) or food rich in this substance Yeast is used for this purpose

Kwashiorkor

This is a deficiency disease of children, which has been reported especially from East and West Africa. It is usually associated with weaning, when the child is deprived of milk, and given a diet of maize, plantains, and cassava, or similar carbohydrate-bearing foods in which the proteins and vitamins are insufficient for its needs. The liver is grossly affected, and even if the child recovers, the liver may have been permanently damaged (see cirrhosis, above) There may also be infection with intestinal worms, or malaria.

Symptoms. The child is irritable and weak, with oedema, loss of pigment from the hair, a curious condition of the skin known as crazy-pavement skin, inflammation of the mouth and tongue, diarrhoea, and anaemia. The oedema may give a false impression of plumpness

Treatment. The important feature of treatment is to give the child a diet rich in good protein—milk and eggs if they will be taken—and adequate in vitamins.

Prevention. A reasonable diet, such as is customarily given to European infants, would obviously prevent this condition, but the basis of such a diet is cows' milk, and in some of these African communities the use of milk is not customary, and the cattle are not exploited in this way. To change a mode of life, and substitute new for traditional customs, is difficult, but must be attempted.

Scurvy

Cause. Scurvy is due to deficiency of vitamin C in the diet. At one time it was the most dreaded disease of sailors, who lived, on long voyages, too much on cereals and preserved foods. Vitamin C is present [illegible]

of vitamin C in the winter months was the potato, but its content of the vitamin is never high, and is lowest in winter.

Vitamin C is an acid (ascorbic acid) and is easily destroyed by cooking too long or re-cooking, by cooking with an alkali such as cooking soda, or, especially, by exposure to the air. Thus, the vitamin C content of green vegetables may be ruined by prolonged boiling with soda, and of potatoes by mashing them and then allowing them to stand before they are eaten. Foods which contain this vitamin, if they are to be cooked, should be cooked thoroughly but briefly, and eaten at once. Fortunately, the fruits of the tropics provide an ample supply, and many need not be cooked.

Symptoms. The patient with fully developed scurvy is very ill. [illegible]

is anaemic, his heart very much weakened, and he may have oedema of the legs. Cases of scurvy have been seen in certain industrial undertakings in Africa in which the diet issued to the men was poor in vitamin C.

Treatment. For the acutely ill patient synthetic ascorbic acid may be given, but most cases respond to natural vitamin C, in *orange or lemon juice or other fruits, or in raw onions, potatoes,* or swedes.

Prevention. This is evident.

Rickets

Cause. One important factor in rickets is a poor supply of the vitamins of the D group in the diet. These vitamins exercise a powerful effect on the absorption and utilization of calcium taken in by the mouth, and if they are lacking the formation of bone is seriously disturbed.

Vitamins of this group are soluble in fats, and are found in dairy produce, and *in fish liver oils. But man and animals are able to* manufacture these vitamins by the action of sunlight on the natural oils of the skin; exposure of the unwashed skin to the sun is, in fact, the greatest reason why rickets is not common in the tropics. The vitamins thus formed are probably absorbed through the skin. In countries where religious custom forbids women to walk abroad unless they are completely covered with clothing, rickets is by no means uncommon.

It is thought that another cause of rickets is a poor supply of calcium salts in the diet, as in some parts of West Africa, and India, and in that case efforts are made to induce the people to make as much use as possible of available supplies of edible calcium, such as fish bones

Symptoms. The rickety child is fretful; has a large head whose bones are late in uniting; a pigeon chest because the ribs are soft, and distorted by the coughing due to bronchitis, which is common; a protruding abdomen; and, most striking of all, bent legs. The bones of the pelvis of female children may be so deformed (because they are poorly formed, and soft when weight is put on them) that there is a permanent obstruction to subsequent childbirth. The rickety child is subject to convulsions and susceptible to other diseases; the development of teeth is much delayed.

Treatment. For rickets the treatment must include adequate supplies of these vitamins, but when structural damage to bones has developed it may be necessary to correct it by surgical means.

Prevention. The provision of a good mixed diet is an obvious need. The rigid confinement to which girls are subjected in some religious communities, and which interferes with the proper formation and growth of their bones, should, of course, be mitigated, but any change in these customs must be the result of persuasion rather than compulsion, unless that compulsion is exercised by the religious authorities themselves

These food deficiency diseases are important enough from the point of view of the individual patients, and it is the duty of administrative, as well as of medical, officers to provide treatment and the means of treatment for these patients. But they have the further enormous importance that they provide one very definite indication that the social conditions of the people are seriously wrong The existence of a few cases of definite deficiency diseases implies much more than those cases, it implies a much larger number of mild cases, and a general standard of nutrition which cannot be accepted as satisfactory. The existence of such cases should therefore be the indication for an investigation of their cause. If this is obvious famine the remedy may be difficult, but the position, at least, is clear. If the cause is not obvious famine it may lie in the social habits of the people, or in their agricultural methods and customs, or in the influence of industry on their lives, even if the

industry is not close at hand. It is obviously the duty of any government with a sense of responsibility for the welfare of the people, and with a recognition that justice to those people must accompany economic development, to make every effort to discover the true causes of the maladjustment which shows itself in even a few cases of gross deficiency disease. No doubt this maladjustment will manifest itself in other ways—political, economic, and social—but the first striking symptom may be medical, and the social cure needs more than the treatment of the sick; it may need legislation and reorganization of life.

In many of the industrial undertakings established in the tropics it is the custom for the employers to provide their employees with food, either issued raw, for the men to cook themselves, or cooked for them. In most countries governments have issued particulars of the minimum diet scales which must be provided for these employees, but it is unfortunately true that even in quite recent years the actual diet provided, in some cases, has been inadequate to maintain full health. Some people, for instance, have expressed the view that Africans are able to remain healthy, and to perform heavy work, on a diet of maize meal, beans, and salt, with an occasional addition of meat and vegetables. It cannot too strongly be emphasized that this attitude of mind, sometimes, no doubt, the result of ignorance or lack of clear thinking, is stupidly and almost criminally wrong. The Africans, and the indigenous workmen in other parts of the world, are no more able than anybody else to subsist on a poor diet.

Employers who hold these views (fortunately a diminishing minority) are usually those who express themselves most freely on the subject of the laziness of their workmen; they do not know, or they ignore, the large mass of experience which has shown that well-fed workmen are not only more healthy, but work harder and produce more than those on short rations The temptation to economize on food for the workmen is especially noticeable in places where the labourers are recruited for short-term contracts. [illegible] are encouraged to remain [illegible] h [illegible] of procuring it.

The conditions under which men work are subject to legal definition, and although to a great extent the laws are dictated by

medical considerations, and entail responsibility on medical men, the administrative officers are charged with the over-all care of the people. They are eventually responsible for the framing of laws and regulations, and for enforcing them, and they should be vigilant to observe the effects of all existing and new activities on the well-being of their people.

CHAPTER XVIII

DISEASES CONCERNED WITH INDUSTRY

THE health of a tropical population is influenced by many factors—education, nutrition, the social services, mode of life, and economic development Of these, the last may well be one of the most important. Economic development usually means that industries are created which depend upon an organized labour force. The workmen live in towns or in separate communities, and are subjected to illnesses which flourish in such communities or which are inherent in the work itself.

Most of the industries conducted in tropical countries are concerned with agricultural projects, mines, or factories, and although it would be impracticable to attempt a full description of the very numerous hazards to which workmen are subject in these industries, it is necessary to discuss the broad outlines of the subject, and to impress upon the reader the fact that much serious physical disability arises in industry; that most of it is avoidable if the managements take the proper steps; that too often in the tropics these steps are not taken; that laws which are commonplace in Britain may not be in force, or may be disregarded, in the tropics; and that it is the duty of government to see that workmen are protected against diseases they do not themselves understand, and which industrial conditions tend to foster.

Labourers who seek work in organized industries usually do so for a limited period, to earn money, and they usually intend to return to their own homes when they have earned enough for their needs. In some cases, of course, the men remain in permanent employment, and settle into homes, with wives and families, near their work, but it still remains true that most labourers in the tropics are only temporarily employed. The men may travel hundreds of miles by land to reach the place of work, and although the routes along which they travel are, in many cases, provided with means of transport, or with rest-houses at suitable intervals, it is unfortunately still too often the rule that the men make their own way, as best they can, from their own districts to the place of work, and that they not uncommonly arrive, after a journey lasting several weeks, in a state of malnutrition and physical decrepitude which

renders them incapable of effective work until they have been thoroughly rested and nourished, and which may render them susceptible to the prevalent infective diseases It is not to be expected that men living far from the centres of industry can appreciate the conditions they will find on the journey and at the work Very often, therefore, they take with them insufficient money or food to see them satisfactorily through the journey Sometimes, moreover, these men are not housed or fed by the employers, but live in lodgings with the people of the neighbouring villages, and buy their food from them. In consequence of this custom, the villagers have made the provision of shelter and food their primary means of livelihood, and have thrived on it, at the expense of the labourers themselves In some such places attempts on the part of the employers to house and feed the labourers have led to protests by the villagers, of such vigour that the projects have been abandoned; but the interests of the labourers, strangers in the country, are not served in this way Many employers, on the other hand, adopt the more satisfactory custom of providing quarters for single men, and houses for married men, and food ready cooked, adequate in quantity and quality for the needs of the men In such conditions it is usual for labourers to remain in good health, and to increase in weight, during their term of work

It is obvious that, where adequate legislation for the protection of labourers does not exist, or where it is not enforced, there is a great temptation for unscrupulous employers to exploit ignorant labourers. The payment of statutory wages may be avoided if employers use sharp practice, the food issued to the men may be quite inadequate to sustain health; expenditure laid out on housing and sanitation may be insufficient to provide the reasonable minimum standards; measures to prevent malaria, hookworm infection, silicosis, and other diseases associated with tropical industry, may be neglected; little or no compensation may be paid to disabled labourers, who may be turned out from the industry and for whom the employers may disclaim responsibility All these failures to treat labourers in an enlightened manner, and as human beings, important for that reason to themselves, are entirely inconsistent with common humanity, and with the professions of colonial policy. It is the duty of all government officers to insist that no exploitation of labourers is permitted.

Employment of labourers on a large scale, away from their

homes, tends to have an unfavourable effect on social and agricultural conditions, since an important section of the working population is constantly absent, and the necessary cultivation is done by women already overburdened with their ordinary domestic duties. These women look after their families, cultivate the land, tend the animals, and collect fuel; they become mere drudges, and it is not surprising that they farm inefficiently, and that overstocking, overgrazing, deforestation, and soil erosion are features of such land. The women, moreover, resent separation from their husbands, and one African chief has observed that a married woman wants to live with her husband and be supported by him. Sometimes the husbands do not return, and sometimes they return infected with venereal disease or tuberculosis. These social effects are very real, and are engaging serious attention in many countries. One answer might be the establishment of permanent labour forces where this is possible, but the matter is not susceptible of a single, simple remedy. Administrative officers in the districts from which temporary labourers are recruited will best be able to observe the effects of this drain of man-power; they should study them, for they may be most serious.

The various mining industries provide plentiful hazards to health. Mining involves the breaking of rock, usually by means of explosives. If this rock contains silica (quartz)—as it usually does, especially in gold mines—the effect of explosion is not only to break it into pieces of manageable size, but also to create a cloud of particles, some of which are so minute that they can be seen only under a microscope. These minute particles remain suspended in the air for long periods, and if they are inhaled time after time over a period of months or years they tend to give rise to the disease silicosis, a slow fibrosis of the lungs due to deposits of this dust in them. Silicosis permanently reduces the efficiency of the lungs and therefore of the heart, and also predisposes to the development of tuberculosis (miners' phthisis); it is a serious disease, which can be fully diagnosed only by the use of X-ray. In Britain, South Africa, and many other countries, silicosis is a compensatable disease, and elaborate laws have been enacted to enforce preventive measures and to ensure compensation, but this is unfortunately not true of all tropical countries. The chief preventive measures are: careful medical examination of recruits to the mines; the institution of dust-suppressive methods of mining (wet-drilling,

blasting at the end of working shifts only, ventilation); regular examination of men exposed to risk. It is sometimes claimed, by interested persons, that this or that mine has no silicosis hazard, but such statements should be distrusted unless they are based upon reliable investigations; the dangerous particles of dust are invisible, and can be detected only by special instruments in the hands of trained investigators

Men who work in mines run the risk of other diseases than silicosis Coal-mines carry their own dust hazards, in which silica plays a part, but in which other dusts are also important Mines are also liable to the hazard of hookworm infestation, especially, of course, if sanitary arrangements below ground are poor, and if infected men foul the ground with their faeces Accidents are inevitable in mines, no doubt, but they can be greatly minimized if a serious attempt is made to do so.

On plantations there may be serious health hazards from malaria, schistosomiasis, and hookworm infection, as well as from cerebrospinal meningitis and other crowd diseases. Malaria is the constant menace to labourers on plantations, or living in quarters at or near mines in tropical countries, elaborate and careful preventive measures may be needed to control this disease, but it has repeatedly been shown that prevention is possible if local expert advice is taken. Many plantations depend upon irrigation, which favours malaria, and experience has proved that in countries in which schistosomiasis exists this disease is seriously fostered by the opportunities for infection which irrigation provides The conditions for cultivation of tea and coffee are very favourable for the survival of larvae of hookworm in the soil, and indiscriminate fouling of the ground by the labourers, in the absence of sufficient latrines [illegible]

tracting [illegible]

mines are of very obvious importance to health. Ulcers, especially of the legs, are common in plantation labourers, especially when the work involves the risk of small injuries (such as may be inflicted by the sharp spikes of sisal leaves) which, if not cleaned and dressed quickly, are apt to develop into spreading ulcers

In tropical countries many industries are being developed which involve work in factories. In some of these there are hazards inherent in the work—for instance, the risk of silicosis in sand-blasting, tile-making, &c., and of serious poisoning in the many industries in which organic solvents are used—but in all there are potential hazards arising from poor construction and inefficient ventilation and heat-insulation of the factory buildings themselves. It would not be possible in a small book to give an account of the multitude of dangers to which factory workers may be exposed, but for the administrative officer it is perhaps enough to say that factories in the tropics should be visited regularly by competent inspectors who know the likely faults, and that the administrative officers themselves may help by applying for expert supervision of all factories in their areas. Factory legislation in the tropics is often rudimentary, but administrative officers can often usefully press for improvement, and can ensure that existing regulations are carried out. The conditions in which many tropical factory workers are employed are very bad.

One other disease may be mentioned. Anthrax is an occupational risk in men dealing with hides The anthrax bacilli or spores may persist in the dried skins of sheep or cattle which have suffered from the disease, to infect those who handle them. It may take the form of a quickly-developing skin infection with a black centre surrounded by an inflamed and swollen area. This is known as a [illegible]

The other form of anthrax is due to inhalation of the bacilli or their spores, and is essentially a form of pneumonia; it is a deadly infection, sometimes known as wool-sorter's disease. Anthrax may also be acquired by eating the flesh of an animal which has died from it, and which has not been properly cooked; this is hardly an occupational disease, but malignant pustule and wool-sorter's disease undoubtedly are hazards of those who work with cattle and hides.

SECTION 4

PUBLIC HEALTH

CHAPTER XIX

HOUSING

In the tropics houses must obviously be planned and built so that they provide adequate protection against heat. It would not be possible in a small book to give the details of plans and materials, and officers who are compelled to build huts or bigger dwellings should consult the public works department, whose duty it normally is to undertake building operations. But some of the principles to be followed may briefly be indicated.

The building material should have good insulating properties, should be easily procured, and should resist white ants. Stone is usually excellent but may be difficult to get or to work. Nevertheless, if stone can be used it is the best material. Concrete blocks are much used. They can often be made on the spot or be obtained [illegible]

able. They do not stand strain well and may collapse. Rammed earth (*pisé-de-terre*) has been used but unless the earth is of the right kind, and unless it is of the right degree of moisture when it is rammed between the shuttering boards, it is not very successful. Mud-and-wattle construction is traditional in most countries. It is cool but unstable, and, like mud brick and rammed earth, it will not [illegible]

timber impregnated with DDT or other insecticide may resist white ants. If this proves to be so, the use of timber for building may be very greatly extended.

For roofing, tiles are probably best, but corrugated iron is much used though its insulating properties are bad. If either of these materials is used, there should also be a ceiling of sheets of fibrous material, or wood, and there should be good circulation of air between ceiling and roof. Thatch is cool, but harbours many

insects and may harbour rats. It is not always rain-proof in a tropical downpour, and it is very inflammable in the dry season.

Floors are usually made of cement, which can be washed frequently. Wood floors are difficult in that ants can attack them. Beaten earth or earth and cow dung may be the only available material for floors. These may harbour ticks and chiggers.

Good insulation is necessary for keeping the interiors of buildings cool, but this property may be supplemented by making use of the fact that light colours reflect, rather than absorb, heat rays. For instance, the interior of a room whose outside walls are whitewashed is several degrees cooler during the hottest part of the day than a similar room whose outside walls are dark in colour. The heat rays are to some extent reflected back when they strike the whitewash, and the amount of heat penetrating the walls is therefore reduced. This has been shown experimentally in West Africa, and, no doubt, is the reason for the traditional whitewashing of buildings so common in hot countries

A similar, but even stronger, effect is produced if sheets of aluminium foil are used to reflect heat These are placed, not in the open, but underneath the iron roof or in the wall structure, and they must have an air space between the bright side of the sheet [illegible] A layer of [illegible] in [illegible] s a lining for sun helmets [illegible]

exposed to the afternoon and evening sun, and the same is true of louvre shutters for exposed windows, or even overhanging shades for individual windows.

Windows themselves should usually be large, especially in coastal areas or islands, where very high temperature is prevented by the proximity of the sea. Here the utmost possible movement of air is desired inside a building, as a relief from the moist heat, and windows should therefore be big. In desert countries the air at midday may be so hot that it is a relief to restrict the entry of the wind, or to filter the wind through a brushwood screen kept moist. These arrangements can be made with shutters and screens. Metal gauze is much used to keep out mosquitoes, and is very necessary

in most parts, but there is no doubt that the gauze interferes to some extent with movement of air; this is another reason why windows should be large

If possible, doors and windows should look out on to grass or green foliage. If they look on to gravel or sand the heat of the sun is strongly reflected into the building Shade trees are also most important so long as they do not restrict the wind movement unduly. A tent pitched under a tree will be much more pleasant to live in than one in the direct sun, and grass is more comfortable than bare earth. A growth of green creeper on a house wall may do something to keep it cool A deliberately cultivated garden (if water may be obtained in sufficient quantity) is not only an amenity pleasant to work in and to see, it may be made a source of valuable fresh foods, and (more to the point of this chapter) it will probably add very greatly to the actual climatic comfort of the house. Moreover, a cultivated garden is much less dusty than a sandy compound

The site and orientation of a house are most important In general, high ground is better than a low-lying site Mosquitoes are not so likely to find on hill-tops suitable water in which to breed (though some species may do so in small springs and seepages) and hill-tops catch the breeze This is only a generalization, of course, and there are places in the tropics where high ground is too exposed to strong winds to be suitable for dwellings It is usually wise to clear the bush and scrub growth for some distance round a house, though big shade trees and evergreen shrubs may be left, or planted. Undergrowth conceals mosquito-breeding places and shelters mosquitoes during the daytime; in Africa it may favour tsetse and other flies; it gives shelter to snakes and to bigger, destructive animals

The house should, if possible, be orientated so that all rooms catch the prevailing breeze, and so that bedrooms do not face west. Nothing is more unpleasant than to go to bed, under a mosquito net, in a room which has been heated by the afternoon sun and in which the hot air is also stagnant.

As a rule, the kitchen is a separate structure, a few yards awa from the house, and sometimes included in a block which contai the servants' quarters. In country districts wood is the only fu and the kitchen walls soon become grimy with smoke from stove. The soot itself is harmless, but officers should inspect kitchen regularly, and insist that soot be cleaned up, beca

slackness in this respect will encourage slackness in relation to other forms of dirt which may be more harmful, for instance fragments of food. Servants' quarters must be kept clean, and although it would be unwise for officers to intrude too much on the privacy of servants by entering their rooms, they will obtain a good impression of the state of the inside of the buildings by inspecting the outside. If servants are to keep themselves clean, they must be

The foregoing remarks refer to the housing of Europeans in hot climates. The housing of the indigenous people offers different problems, some of which may need to be solved by government *officials, employers of labourers, or missionaries.* The general principles concerning materials and heat insulation are the same, but the question of cost differs in that it is unusual for sufficient funds to be available to provide labourers, police, &c., with houses of any-

protection from the sun and rain is now ending, and the tropical peoples will soon demand (and should have) homes which offer some of the graces of life Labour lines and housing estates, therefore, need to be planned with care, both from the point of view of satisfactory individual buildings, and of the community as a whole. Village- and town-planning is a subject which is now receiving much attention, and which includes knowledge of building techniques, of sanitation, geology, forestry, agriculture, architecture, and social science. It is obviously important that a sound beginning should be made in any housing scheme, since it is difficult to alter a programme once it has been started. Much study has been given to the subject, and there is now a growing literature on tropical village housing and planning, and officers should make inquiries about this literature before they make or accept plans. It is likely that administrative officers will be required to correlate the activities of officers of the medical, agricultural, public works, and other departments, and apportion to them appropriate shares of available funds or man-power. To do this effectively, and with reasonable authority, the administrative officers should be well briefed, and the advice of a village-planning expert, or an architect,

may be invaluable. It may not be available except in books, but the administrative officer should at least apply to his own headquarters for such advice.

It is worth remembering that uncontrolled building in a village may lead to gross overcrowding owing to multiplicity of small huts in a confined space, and, on the other hand, that any form of hut tax may lead to overcrowding of families in too few houses. A balance must be preserved, which will depend very largely on local conditions, but which will entail some form of control of building, and legislation to regulate it. The report on *The Anchau Rural Development and Settlement Scheme*, by T. A. M. Nash (H.M.S.O. 1948, 3s. 6d.), is worth study as an account of a successful effort in West Africa.

CHAPTER XX

WATER SUPPLIES

An adequate supply of water for drinking and domestic use is an essential of life, and, if health is to be preserved, this water should be free from contamination by parasites which cause human disease, and should not contain any dissolved substances in such concentrations that they can injure health. The water should be reasonably clear and palatable, and it is an advantage if it is reasonably soft. Most waters are acceptable in so far as physical characters and dissolved substances are concerned, but many natural waters are rendered potentially dangerous to man because they either are, or are likely to be, contaminated by human or animal excreta, which may contain bacteria or other organisms that give rise to disease. In primitive communities the connexion between excreta, water, and disease is not comprehended, and it is usual for open water, in rivers, streams, springs, wells, and water-holes, to be constantly contaminated. There is little doubt that this contaminated water is one of the important causes of the high infant mortality which is always a feature of such communities, and of the frequent epidemics of intestinal diseases which mark the tropical countries.

The European who goes to live in a primitive society has not, as a rule, acquired immunity to the many diseases conveyed by contaminated water, and is likely to be affected seriously by contamination which would have little effect on the 'salted' adult native population. For his own protection, therefore, he should take scrupulous precautions to ensure that the water he drinks, or with which he washes his teeth or his utensils, is harmless; and also that he is protected by immunization against those water-borne diseases for which vaccines are available—fevers of the typhoid group and cholera.

For the water itself, the first and basic precautionary measure is to see that it is kept free from contamination, from the source to the consumer; if this is not possible it must be rendered safe by treatment, either by boiling or by the application of chemicals to kill contaminating bacteria. Water treatment is carried out on

a large scale in organized water-works, but where these do not exist sterilization must be performed by the individual user.

Water for domestic use may be derived from several sources:

1. Rain-water collected from roofs into tanks This is the normal supply in some of the Pacific islands, parts of British Guiana, British Honduras, and elsewhere.
2. Lakes or ponds
3. Springs, streams, or rivers
4. Wells or water-holes.
5. Distilled sea-water, as is used in ships

Water from lakes, springs, rivers, and wells may be collected, eated to render it safe, and distributed by a pipe system to ndividual houses, as is customary in Britain. If this is done, and f the competent water authority declares that the water is safe for consumption, the user is relieved of responsibility for sterilization But in most parts of the tropics no attempt has yet been made to provide a safe supply except on a small scale in some rural areas, and on a large scale in some of the cities and towns.

All these waters, except the distilled sea-water, are open to contamination from animal or human sources Roofs are fouled by birds, and possibly by rats, streams and rivers may be used for washing, bathing, or as latrines, above the point at which water is drawn for drinking; wells and water-holes, unless protected, may be contaminated by users of the wells or by animals Water taken from contaminated sources needs sterilization, but some of the sources themselves may be so protected as to render sterilization unnecessary

Such sterilization of water as can be carried out by the individual ouseholder in his own home is, in practice, confined to boiling, nd this is the safest and most effective method of rendering water armless. In many tropical countries porcelain filters are issued to government officers, the tacit assumption being that the use of these will suffice for the purification of water. This assumption is completely unjustified Filters soon become clogged unless the porcelain candles are scrubbed and boiled every few days, and it is quite possible for bacteria, including those which cause intestinal disease, to grow through the candles, multiplying in the process Moreover, candles are easily cracked, or may be replaced in the filters in faulty position, so that water may pass them unfiltered. Officers will be wise completely to abandon the use of filters; they

give a false sense of security, and may be extremely dangerous. Boiled water, cooled in a clean receptacle, is safe and is usually palatable. The more elaborate methods of sterilization, for instance by chlorination, are not usually suitable for domestic use, though they may be applied if the water-supply for a community is stored in tanks or reservoirs. Chlorination, however, requires expert knowledge, and will not be described in detail here.

Water from roofs, lakes, ponds, streams, rivers, and water-holes should be boiled before being used for drinking or for cleaning the teeth. As a rule, these sources cannot be protected against human or animal contamination, and should always, therefore, be regarded as unsafe. Water from springs or wells may, or may not, need to be boiled, according as the source is protected or not. Distilled water is sterilized in the process of distillation.

From the point of view of the European resident in a tropical country the question of protection of a source of water is, in effect, the question of proper construction of wells, or of protection of springs.

The geological formations which comprise the surface layers of the earth are disposed in strata which may be parallel to the surface, but which, more usually, are bent into folds or basins, or are inclined at an angle to the surface. These strata may have been fractured and become dislocated, the line of fracture being known as a fault. The diversity of inclinations and directions shown by geological formations makes it almost impossible to judge the underground formations from those of the surface.

Some of the strata are porous, or permeable, to water; others are impermeable, but may allow water to pass at fractures (faults), or may contain water in fissures or hollows. Thus, chalk itself is impermeable, but prolonged action of water containing carbon dioxide dissolves large parts of the chalk, creating caverns or fissures which contain water. In such caverns or fissures there is no *filtering action.*

A *spring* is formed where an impermeable stratum reaches the surface of a hill-side or declivity. Rain-water percolates through the soil above this stratum, but cannot penetrate the stratum itself; the water flows downwards and emerges where the impermeable layer reaches the surface.

Wells are holes driven into the earth deep enough to reach the water-bearing, permeable, strata. A *shallow* well, or a *water-hole,*

is dug only so deep as to reach the subsoil water, possibly a few inches, or perhaps many feet, below the surface. Such a well may reach, but does not penetrate, the first impermeable stratum. A *deep* well is one which is driven through the first impermeable stratum, so that it taps the second permeable layer An *artesian* well is a deep well bored in such circumstances that the general level of the water it taps is above the level of the well-head, so that the water gushes out of the well by its own force.

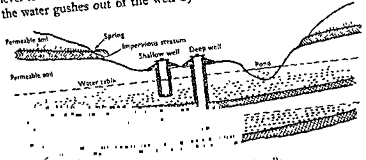

FIG 26 Water-bearing strata and wells

Rain falling on permeable earth soaks into it, and in this process is subjected to filtration. If the soil particles are fine, and if the water has traversed a considerable distance of this filtering soil, any bacterial contamination that may have been present in the water on the surface of the soil, is likely to have been removed, and the water is in this respect safe. If, however, a shallow well, or a water-hole, has been dug, the distance traversed through the soil by rain-water falling near the well may be too short for effective filtration, ... the immediate confines of the well may run into ... whatever Surface water ... certain to be con-taminated in primitive countr... precisely here that people congregate, in large numbers, to contaminate the surface water by their feet, or even by urinating or defaecating near the well. In dry weather there is no surface water, but if (as is so often the case) indiscriminate defaecation within a short distance of the water-hole is customary, it is evident that the first rain of the season is likely to sweep infective material into the water-hole either along the surface, or by percolation too short to be protective through the dry soil. Moreover, it is a common custom for users of a

water-hole not only to dip their unclean hands and vessels into the water, but even to walk into it and wash themselves in it For these reasons, shallow wells (*unless adequately protected*) *and water-holes* should always be regarded as dangerous.

Deep wells are usually safe, provided that the well-head, and the sides of the well, are properly constructed, and that contaminated water does not enter through the well-head. They are safe because, as a rule, the water in them has percolated long distances through the soil, and has therefore been thoroughly filtered. Artesian wells are also usually safe, *for the same reason.*

The emphasis, in relation to wells, is evidently on proper construction, if they are to be rendered safe, and there are certain features of properly constructed wells which should be understood.

1. There should be no source of possible contamination, such as a latrine, cesspool, manure heap, or farm-yard, within at least 100 feet of the well; and the natural flow of subsoil water should be from the well towards any source of contamination, never in the opposite direction Determination of the direction of flow of subsoil water is a matter for experts.

2. An area surrounding the well should be railed off. This is, perhaps, a counsel of perfection, and is only useful if the water from the well is pumped to a tank outside the railed area, and distributed there

3. The well should be lined with bricks set in cement, or by pre-cast concrete cylinders, to a level below that of the water tapped. This lining should be water-tight so that water can enter the well only at the bottom. For deep wells this water-*tight lining* should be carried down to the first impervious stratum. Water companies often use steel tubing, or cast-iron circular segments, for lining wells.

4. The lining should be carried up the well-head as a coping 2–3 feet above ground level, and the well should be closed by a proper cover.

5. *The ground for at least 6 feet around the well-head* should be covered with a stout layer of cement, sloping away from the well, so that any water spilled near the well is forced away from it.

6. If a pump is provided it should be placed a few feet away from the well, and waste water from it should be conducted into

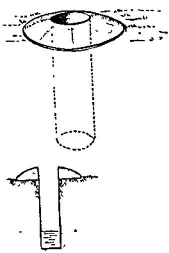

Fig 27 Well-head of concrete.

Simple type to prevent drawn water from re-entering the well.

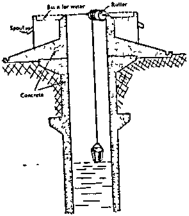

Fig 28 Well in section Nigerian type.

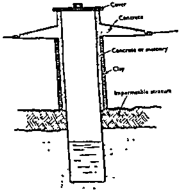

Fig 29 Deep well, simple type

The well passes through the first impervious stratum, and the lining reaches that stratum. The lining should be water-proof, to prevent entry of water from soil above the impervious stratum

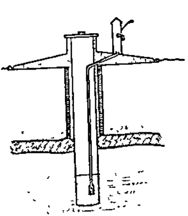

Fig 30 Deep well, with pump

oxidizing power; but if there is much organic matter in the water, the oxidizing power of the permanganate is expended on the organic matter, and a brown compound is formed If the water is brown, it is a sign that there is no free permanganate left to act on the bacteria

It would be most unwise to rely completely on this method, but it has some value in helping to control epidemics of cholera.

CHAPTER XXI

SEWAGE AND REFUSE DISPOSAL

Sewage Disposal

The disposal of human faeces, and, to a very much smaller degree, of human urine, presents a health problem of the very greatest importance for the reason that so many of the organisms which cause human disease are excreted in the faeces, and sometimes in the urine; and if these infected faeces or urines are so discharged that they can contaminate water or food subsequently consumed by man, the diseases may be spread. The eggs or larvae of all the intestinal worms, the protozoa of amoebic dysentery, the bacteria of typhoid, cholera, the dysenteries, and of other intestinal diseases, and the virus of infantile paralysis and perhaps of other diseases, may be found in faeces. The eggs of one of the schistosomes and the bacteria of typhoid may be found in urine, so also may the organisms of gonorrhoea, but this is of little importance in this respect since man does not become infected with gonorrhoea by water or food contaminated by that organ-

the subject of some of the Mosaic laws, the true reason why they are potentially dangerous to man was not appreciated until the study of helminthology, protozoology, and bacteriology revealed the infectivity of excreta. It is a common belief of primitive peoples that if an enemy obtains one's faeces, he may by witchcraft be able to use them to one's detriment But the spell is specific, the faeces of another person cannot be used against one. Such beliefs may perhaps be turned to useful ends if they are robbed of their supernatural element, and are invested with the authority of actual truth, namely, that in the natural state, any human faeces are a potential danger to any person. But it is also likely that a deep-rooted superstition of this kind may be a very distinct bar to sanitary progress. For instance, it is commonly held that if the faeces are deposited in secret behind some bush, or on a seashore with many other deposits, the enemy will not know where to look for the specimen on which to work his spells, or will not recognize it

among all the others. But if the enemy knows that his intended victim uses one latrine exclusively, and especially if he alone uses it, the enemy can obtain his specimen with certainty.

Other customs and beliefs may affect sanitary reform. For instance, in some communities it is forbidden to pass faeces inside a house. The superstructure over a pit or *bored-hole latrine* is regarded as a house if it has a roof; if there is no roof it is not a house and may therefore be used. Thus, the simple fact of omitting a roof may make the difference between success or failure of a sanitary programme. This is an actual instance, and, no doubt, others just as strange to western ideas could be cited.

On the other hand, in countries where human faeces are used, in their fresh state, to fertilize the soil, and are collected and spread by people who have no fear of them, the spread of the intestinal diseases is so facilitated that vast epidemics, for instance of cholera, are not uncommon.

To western people the aesthetic aspect of good sanitation is one great factor in maintenance of good health, but this aesthetic discrimination is not, apparently, a general characteristic of man, [illegible] be cultivated

places in the tropics. The bucket is placed beneath a latrine seat of the usual type, and receives both urine and faeces. As a rule a small amount of disinfectant (cresol, Izal, &c.) is left in the bucket, together with a handful of grass or straw, and it is a good custom for the user to cover the faeces with earth, from a supply kept for the purpose, to prevent access of flies to it. Each day the bucket is removed and the faeces are either buried in trenches or burned in an incinerator; the bucket is rinsed with disinfectant. If this process is efficiently carried out, it is fairly satisfactory, but it depends so much on the human factor and the work of collection is regarded as so unpleasant, that efficiency is difficult to secure; the work is often done by prisoners, never a satisfactory arrangement.

2. *The pit latrine.* This is satisfactory if the soil in which the pit is dug is permeable, and if the pit is deep (10 feet or more) The pit should be covered by a strong platform, and a latrine seat with a lid should be placed on this platform. If the platform consists of wooden beams covered with earth, the danger of white ants and

collapse of the platform with deplorable results to the unfortunate user, should be borne in mind. In a deep and well-covered pit flies will not breed, but in a shallow pit with defective cover, fly maggots may be seen in enormous numbers. There is no offensive smell from a deep pit in porous soil, but if the soil is impervious,

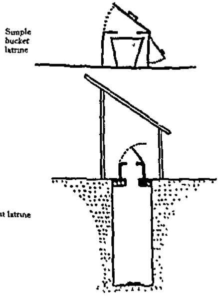

FIG 31 Latrines.

this form of latrine becomes impossible. The faeces and urine in porous soil undergo some liquefaction owing to bacterial action, and tend *to soak away into the soil. If the latrine is well away from* a source of water—stream, pond, well, &c —there is no danger to the water supply. Some pit latrines may be used for years, but others may tend to become full; in this case the pit should be filled in with the earth and another dug.

3 *The bored-hole latrine.* This is made by boring into the soil a hole 16 inches in diameter, with a special augur, to a depth of 20 feet or until water is reached. The sides of this hole are supported by a lining of basket-work or wire-netting made the requisite size, and the top is covered by a latrine box seat of the usual pattern, with a lid, or by a steel or concrete squatting plate if the

latrine is for use by the indigenous people. If the bored hole re[aches] water, the faeces which are deposited undergo bacteriological a[ction] and are liquefied and absorbed into the soil, and the latrin[e can] be used for a very long time. If the hole does not reach water, [there] is still some disintegration and absorption of the faeces as in [a pit]

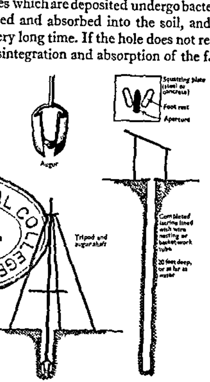

FIG. 32 Bored-hole latrine.

latrine, but the hole may gradually become filled. Bored-hole latri[nes] are easily and quickly made, and squatting plates can be cast [in] concrete, or made from pressed steel, at reasonable cost. T[he] bored-hole latrine may be the answer to many problems of ru[ral] sanitation, and has, indeed, proved to be so in many places. I[t is] obvious that this latrine, and the pit latrine, lead to contaminati[on] of subsoil water, but experience has shown that if the near[est] latrine is more than 100 feet from the source of water, the wa[ter] is not likely to be contaminated, because ground filtration is ad[e]quate. But the farther away the better.

4. *Water-borne sewage systems.* These will not be described [in] detail here, since the construction of even the simplest types enta[ils] considerable technical knowledge. They require an adequate wat[er] supply. The water containing the faeces is led by pipes to a sep[tic]

tank, where bacterial action breaks up the faeces; the fluid overflow soaks into the earth in a specially prepared, covered bed. In the more elaborate types the sewage undergoes various processes in special sewage works, and the final fluid effluent is discharged into a river or the sea.

It is, of course, well known that faeces, both human and animal, contain valuable material for fertilizing the soil. In many countries they are used in the fresh state for this purpose, but unfortunately they contain so many dangerous organisms that their use in this way is likely to lead to much disease. A method has been devised by which faeces may be rendered harmless and yet may retain fertilizing qualities; this method is known as composting It consists of mixing faeces obtained from bucket latrines, with vegetable refuse from house kitchens, and earth, in shallow brick pits; this mass is kept moist and is turned from time to time Bacteriological action within the mass raises the temperature sufficiently high to kill the organisms of disease and the eggs of worms, and in a few months there is left a humus which is without offensive smell, but which has great value as a fertilizer and which is free from danger Success in the process of composting depends on several factors, not the least of which is the care with which the mass is kept at a suitable state of moisture and turned. But composting is a means by which valuable fertilizing material may be returned to the soil to enrich it An account of the Indore process of composting is contained in the *Journal of the Royal Sanitary Institute*, October 1938, p. 279 Advice on the subject may be obtained from the public health department.

If a plentiful supply of water is provided for a house or an industrial establishment, arrangements must also be made for the adequate and safe disposal of waste water as well as of sewage Polluted water must not be allowed to run into a stream or river, and if there is a piped water supply, the waste may be in such quantity that soakage into the ground is impracticable; in this case a drainage and disposal scheme, on a considerable scale, will be needed But for smaller quantities of waste water, and where houses are widely separated, a soakage pit is enough.

Water from kitchen, bathroom (excluding waste from a water-closet), and washing slab is led by drain-pipe to a pit dug so that it offers the maximum possible surface for absorption For instance, a pit 4 feet deep, 2 feet wide, and 8 feet long, offers more surface

than one 4×4×4 feet. Into this pit is placed coarse aggregate (coke, clinker, or even empty food tins) which will support the sides and roof of the pit, but which contains much air-space. The sides and bottom of the pit, of course, must be left unlined, but a roof of concrete, covered with earth and grass, is desirable so that standing water, before it soaks away, is not open to insects. If the ground is not very porous, the area of absorption may be increased by constructing a series of channels leading away from the pit, but still covered.

The pit may be deep enough to reach the subsoil water, but this does not reduce efficiency, for the water soaks away into this subsoil pool. But it is necessary to remember that any water which soaks into the subsoil water, carries any pollution it contains into that subsoil water, and that there should be no well near a soakage pit or latrine.

In the tropics, where mosquito breeding is such a danger to health, it is particularly important to ensure safe disposal of waste water.

Refuse Disposal

In any country, but more especially in the tropics, it is necessary to arrange for the proper disposal of house refuse. If vegetable matter is allowed to accumulate and rot in small collections, it provides a suitable breeding place for house flies, which are not only an irritating nuisance, but are also important carriers of disease in that they pick up organisms of disease if they gain access to faeces, and may transfer them to food. Scraps of animal foods allowed to lie about are also strongly attractive to flies. Refuse heaps which contain discarded vegetable or animal matter, or scraps of food, are very attractive to rats; and, in the tropics especially, rats are dangerous. They are subject to certain diseases (plague, flea-borne typhus, scrub typhus, leptospirosis) which are readily transmitted to man. Empty tins and bottles may collect rain and become highly dangerous breeding places for mosquitoes. For all these reasons, and for aesthetic reasons, the safe disposal of kitchen refuse is important.

In townships where there is a public health service the arrangements for collecting refuse are made by that service, but in small stations and villages very little is done in this respect. Refuse in such small communities is usually thrown round the houses and

left to disintegrate undisturbed. In such circumstances an administrative officer may not be able to do much to institute collection on a large scale; but for his own comfort and health, and as an example to the people, he should make sure that the kitchen refuse from his own house is effectively disposed of as a routine.

Tins and bottles should be separated from organic refuse and should be collected at least once each week for disposal. Bottles may be sold, or, if broken, may be dumped on a controlled refuse tip and covered with earth Tins may be sold for salvage of the metal, or, if this is not feasible, may be crushed and dumped and covered with earth. In Rio de Janeiro the yellow-fever-prevention inspectors perforate all empty tins, before collecting them, so that they cannot hold water in which mosquitoes may breed.

Vegetable refuse (potato peel, fruit debris, cabbage stalks and leaves, &c.) is often burnt in the kitchen fire, and where the amount is not large this is satisfactory Animal refuse (fragments of meat, offal, &c) should also be burnt in this way It is true that burning is wasteful in that the organic material is not returned to the soil, but is dissipated into the air, but the amount lost is small and disposal is thorough. Composting would be preferable if it could be done expertly, but this may not be possible for a single household, and, in fact, is better done on a larger scale by whole-time workmen who understand their business and who are subjected to routine expert supervision.

If there is more vegetable refuse than can conveniently be burnt in a kitchen stove (in police lines or a labour camp, for instance), a regular system of storage in refuse bins of approved design, and of collection and incineration should be instituted The incinerator, which is essentially a large stove, should be situated on the outskirts of any township or village where its smoke cannot create a nuisance, and it should be closely supervised. If the person who attends to the incinerator is careless, and allows refuse to litter the ground, fly-breeding will occur and the place may become infested by rats. Regular inspection of incinerators, by responsible officers, is essential to effective control of nuisances

An incinerator may be constructed of four corrugated iron sheets fastened together to form a hollow cube, with iron bars thrust through near the base (to hold the refuse) and provided with vent holes at the bottom to create draught. More elaborate forms are built of burnt brick, and are provided with a door through which

refuse is tipped, and a chimney. The principle is the same in all patterns, which consist essentially of a large combustion chamber in which the material can be thoroughly burned.

House refuse may be dumped on waste ground, and if the dumping is controlled, and carried out according to recognized practice, it is free from offence. The essential point in controlled dumping is that the material is emptied in a series of 'cells', and that each day's deposit is completely covered on all sides by a layer of earth 6 to 9 inches thick. This must exclude the air from the contents of the cell, and in this sealed space bacterial action takes place which slowly disintegrates the animal or vegetable organic matter, with the production of heat sufficient to destroy all harmful organisms or worms. Flies do not breed in such a dump. Controlled dumping is most suitably done into hollows in the ground; in this way borrow-pits (which tend to collect water in the rains) and other depressions may with advantage be filled in. But unless the refuse is completely sealed, in relatively small cells, the system will fail and fly-breeding and rat-infestation will occur. Refuse containing vegetable matter should not be tipped into water, because it decomposes and causes a nuisance in doing so Hollows containing water may be filled with earth, but if it is desired to fill them with refuse, the water should first be removed.

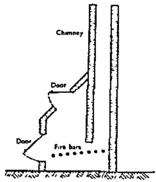

FIG. 33 Incinerator in section.

Markets and slaughter-houses are likely to be prolific sources of

Food markets may be elaborately constructed, with booths and stalls equipped with fly-proof meat safes, with garbage cans for waste matter, and with concrete slabs and floors properly laid out so that they can be washed down and sluiced and the water led away to adequate drains. These large markets are usually under close control of the publ c health department but there are smaller

shelters without walls. In such markets there is a very strong tendency for the people to throw their refuse in untidy heaps round the edges of the cleared space, and this tendency should be checked by the administration through the headman The countless swarms of flies and the large numbers of rats, which are so constant a feature of village life, are evidence of the importance of village sanitation. Headmen should be instructed to burn or bury such market refuse in spots chosen for the purpose, and it should be the duty of the rural sanitary inspectors to advise them how to do this. Moreover, properly constructed latrines should be available for the people using the market, and if possible a controlled supply of water. An administrative officer who throws an inquiring eye round the market or round the village houses, and who insists on tidiness and cleanliness, is perhaps more important than any other person in improving the standards of rural health

Slaughtering places are difficult to cope with Fully constructed abattoirs on the outskirts of towns, provided with all the necessary equipment and staff and properly drained, do not create a nuisance, but where animals are slaughtered in the open on a blood-soaked patch of ground littered with offal and animal faeces and haunted by rats, dogs, hyenas, and vultures there is a putrid offensive nuisance dangerous to health. The least that should be done is to insist that all offal and excrement are burned, and that an incinerator be built for the purpose, with some responsible person in charge If possible an abattoir should be constructed on approved lines, for details of which the public health department should be consulted

Apart from more fundamental preventive measures, markets and meat-stalls or abattoirs should be provided with fully fly-proof meat safes, and fly traps should be freely used. But meat safes must be kept in good repair, and should be inspected frequently.

SECTION 5

PERSONAL PROTECTION AND ORGANIZATION

CHAPTER XXIII

FIRST AID: MEDICAL EQUIPMENT

OFFICERS may be called upon to give first-aid treatment in cases of accident—fractures, gunshot wounds or wounds made by big game, or burns A few notes on the general principles of first-aid treatment may therefore be useful.

For fractured bones in which the skin is not broken (known as simple fractures) the essential first treatment is to immobilize the broken bones by bandaging the limb to a splint (or to a flat piece of wood of suitable size) which has been padded with cotton-wool; but it is most important not to bandage it too tightly, for the tissues swell after a fracture, partly because bleeding has taken place round the bone, and if the bandage is too tight the pressure will rise so high as to restrict or stop circulation, with disastrous results It is a matter of careful adjustment; the fingers or toes of the damaged limb should be pink and warm, not blue or white and cold. The patient should be taken to a doctor as soon as possible. For a compound fracture (in which the skin is broken, and which therefore is likely to become infected by bacteria) the wound should be covered with a sterile dressing of gauze, and the limb splinted as before. Bleeding can usually be stopped by moderate pressure on the wound, effected by applying to it a pad of gauze or lint and bandaging to the appropriate degree of firmness

The last remark applies also to wounds inflicted by animals or by weapons, and in treating these, officers should be most chary of using tourniquets, which are dangerous if applied unwisely, and are generally unnecessary. They are dangerous because their function is to stop all circulation of blood (and thus to stop haemorrhage), and without circulating blood the tissues beyond the tourniquet cannot live long, and may become gangrenous. If a tourniquet is used, therefore, it must be loosened for a few minutes every 20 minutes or so (unless the bleeding is too severe to allow this), so that some circulation of blood is maintained. As a rule,

the severe bleeding stops fairly soon and when it has done so the tourniquet should be removed altogether. But haemorrhage can usually be controlled by moderate pressure of a pad of gauze and a bandage on the wound itself. The gauze should be fresh from a sterile packet. For big wounds needing stitches the patient should be taken to a doctor.

Wounds made by large animals are usually heavily contaminated and need expert surgical treatment, but officers can help by giving good first-aid treatment. A dab of iodine on the raw surface is helpful but by no means infallible, it should be used somewhat sparingly.

For extensive burns, the part should be covered with sterile gauze, cotton-wool, and a fairly tight bandage The patient will suffer from shock and should be put at rest and given plenty of fluid, including tea or coffee, and taken to hospital Small burns may be treated like wounds; they tend to become infected

Equipment

For use in tropical countries a first-aid medicine chest may well contain the following pieces of equipment and drugs

Syringes. One 5-c c Record-pattern syringe, with 6 stainless-steel needles.
One 1-c c Record-pattern syringe, with 6 stainless-steel needles.

Knives One surgical scalpel.

Needles. A few straight and curved surgical suture needles.

Sutures Three ampoules of surgical catgut and a few silk sutures, some stout cotton

Forceps. One pair of artery forceps, and one pair of dissecting forceps

Scissors. One pair.

Dressings. White lint and boric lint; one packet of each
Gauze, one roll.
Bandages (2 inches wide), one dozen.
[illegible] wide), one roll

Splints. [illegible]
cotton wool, secured to them by bandages, before use.

Drugs. Quinine bihydrochloride tablets (5 grains), 200
Mepacrine tablets (0 1 gramme), 100.

CHAPTER XXIV

PERSONAL PROTECTION: EFFECTS OF HEA

ALTHOUGH the various personal precautions to be taken to avo the different diseases have been mentioned in the appropriate se tions of this book, it is useful to bring them together briefly one chapter They may be considered under the following head immunizations, prevention of insect-borne diseases, prevention water- and food-borne diseases, and prevention of affections du to climatic factors.

Immunizations

These are sometimes referred to as inoculations or vaccination The reader should understand that a vaccine consists of an emu sion of the organisms which cause a disease (usually bacteri rickettsiae, or viruses) In some vaccines these organisms are kille and in others they are weakened by various means (but not actuall killed) so that they do not cause the true disease when they ar injected. The object of a vaccine is to stimulate the specific defence of the body against that particular organism, without provokin illness, so that if the person encounters the truly virulent organism in the near future, as, for instance, by drinking water containin typhoid bacilli, his defences are in a position to destroy them. I is known that an attack of true typhoid fever or small-pox, if no fatal, leaves the patient on recovery so strongly resistant to any nev infection by those diseases that he is usually immune for life. Th object of artificial immunization is to administer the killed o weakened organisms, in calculated doses, so that similar immunit may be safely provoked. But the reader will understand that th artificial immunity falls very short of the immunity conferred b actual disease—though, of course, it does not carry the same risk as the natural disease. Vaccines may be used in treatment of certain diseases, but their chief use is in prevention.

On the other hand, a serum is quite different from a vaccine. Serum is the fluid part of the blood (after removal of the red and white corpuscles and the clot) of an animal (or man), and a serum used for treatment of a disease is one which is able to kill the organism of the particular disease, or to neutralize the poison it produces. This serum is prepared by injecting into an animal

(usually a horse) a series of small doses of the agent of the particular disease, each dose too small to kill the animal, but each dose bigger than the preceding one. The defences of the animal are thus stimulated until it can withstand enormous doses, by virtue of protective substances which develop in its serum, and a relatively small amount of this serum is enough, when injected into a human patient, to help him to combat the disease until his own defences are in full operation. For instance, for the serum used in the treatment of diphtheria, the toxin (poison) of the diphtheria bacillus is injected in a series of increasing doses into a horse and the serum is then collected and stored. It is obvious, of course, that the horses used for the purpose of providing serum are carefully examined and kept free of other diseases. The difference in action between a vaccine and a serum is that the vaccine stimulates the body to create its own protective substances, whereas a serum provides these substances already formed. The action of serum is therefore only temporary; the effect of a vaccine is much more lasting.

Vaccines have proved useful in the prevention of certain diseases only, and although attempts have been made to prepare them for many more, they have not been successful. The processes of [illegible]

1. *For typhoid and the paratyphoid fevers A and B.* The vaccine is known as TAB; it was developed in England in the early years of the [illegible] vaccines of foreign origin. TAB consists of an emulsion of killed organisms of these diseases.

TAB is injected under the skin in two doses. The first dose for an adult is 0·25 c.c., the second 0·5 c.c., but for children and peop[illegible] below average development the doses are smaller. The [illegible] between doses should be 3 or even 4 weeks, rather than 2. In [illegible] cases there is a slight swelling at the point of injection, which [illegible] persist for some days, and may be painful. In a few [illegible] is some fever. But these reactions are slight; they are [illegible]

CHAPTER XXIV

PERSONAL PROTECTION: EFFECTS OF HEAT

ALTHOUGH the various personal precautions to be taken to avoid the different diseases have been mentioned in the appropriate sections of this book, it is useful to bring them together briefly in one chapter. They may be considered under the following heads: immunizations, prevention of insect-borne diseases, prevention of water- and food-borne diseases, and prevention of affections due to climatic factors.

Immunizations

These are sometimes referred to as inoculations or vaccinations. The reader should understand that a vaccine consists of an emulsion of the organisms which cause a disease (usually bacteria, rickettsiae, or viruses). In some vaccines these organisms are killed and in others they are weakened by various means (but not actually killed) so that they do not cause the true disease when they are injected. The object of a vaccine is to stimulate the specific defences of the body against that particular organism, without provoking illness, so that if the person encounters the truly virulent organisms in the near future, as, for instance, by drinking water containing typhoid bacilli, his defences are in a position to destroy them It is known that an attack of true typhoid fever or small-pox, if not fatal, leaves the patient on recovery so strongly resistant to any new infection by those diseases that he is usually immune for life. The object of artificial immunization is to administer the killed or weakened organisms, in calculated doses, so that similar immunity may be safely provoked. But the reader will understand that the artificial immunity falls very short of the immunity conferred by actual disease—though, of course, it does not carry the same risk as the natural disease. Vaccines may be used in treatment of certain diseases, but their chief use is in prevention.

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Vaccines have proved useful in the prevention of certain diseases only, and although attempts have been made to prepare them for many more, they have not been successful .The processes of immunity vary, and a procedure effective in one condition is not necessarily effective in another. This is even more true of curative sera, which have been found applicable to even fewer diseases

The vaccines in general use are as follows

1. *For typhoid and the paratyphoid fevers A and B* The vaccine is known as TAB; it was developed in England in the early years of the century, and its use in the wars of 1914–18 and 1939–45 reduced the incidence of these diseases, in comparison with previous wars, to almost negligible proportions The British and United States TAB vaccines are highly effective, more so than some vaccines of foreign origin. TAB consists of an emulsion of killed organisms of these diseases.

TAB is injected under the skin in two doses. The first dose for an adult is 0 25 c c , the second 0 5 c c , but for children and people below average development the doses are smaller. The interval between doses should be 3 or even 4 weeks, rather than 2. In most cases there is a slight swelling at the point of injection, which may persist for some days, and may be painful In a few cases there is some fever But these reactions are slight, they are obviously

the high bedposts, and the bottom of the net should be tucked under the mattress. The sleeper is thus completely enclosed, and there is no gap through which mosquitoes can enter (see p. 28).

Special fine-mesh sand-fly nets are used in some places, but they should be acquired on the spot if they are needed.

The rooms in which people spend the evenings and nights may be protected at windows and doors by metal gauze of standard mesh, to keep out mosquitoes. In addition, both men and women may need to wear in the evening garments which offer as little skin as possible to mosquitoes—long trousers with mosquito boots to the knee, long sleeves, closed neck-bands. Mosquitoes tend to bite at the ankles, especially under tables and chairs, but they will attack any exposed skin, and ordinary stockings and socks do not protect against them. Repellent substances such as dimethyl phthalate may be usefully applied to exposed skin if no other protection is possible, but should be kept away from the eyes.

Mosquito bed nets are usually provided for newcomers to the tropics, by government, or missions, or commercial firms, and there is usually no need to buy these beforehand. The proper clothing, however, should be procured before an officer or his family proceeds to the tropics, but it is advisable for him to ask advice from official sources before he sails, as to what kind of protective clothing he should buy.

One effective means of reducing the number of mosquitoes in a house is to spray walls and dark recesses with a 5 per cent. solution of DDT in kerosene The solution and the hand-spray can usually be obtained in the country concerned.

Suppressive treatment of malaria by mepacrine has proved its value during the war, and a supply of tablets, each of 0·1 gm., may be needed but can usually be obtained locally. Advice as to dosage should be sought of the medical officers on the spot, but where transmission is heavy a daily dose of 0·1 gm. is effective for an adult; it will turn the skin yellow. Paludrine is free from this objection, but the dose required is still the subject of debate. It is probable that some strains of malaria parasite need bigger doses than others, and in West Africa it may be necessary for an adult to [illegible] go [illegible] malaria if taken regularly. The preventive dose advised for an

adult is 0·5 gm. once each week, on the same day of the week. These doses may need modification in the light of later experience in different parts of the world. (See Chapter III above)

The precautions to be taken against tsetse flies, ticks, and other insects have been referred to in other chapters If there is any chance of louse infestation (for instance, for people working in an epidemic of typhus), the use of 5 per cent. DDT powder in talc, for impregnating underclothes, is essential Care should also be taken that clothing should be tight at ankles and wrists and that the feet and ankles should be well protected. The same is true for those working in an outbreak of plague

Prevention of water-borne and food-borne diseases

For *water* the guiding rule is that, unless it is vouched for by the public health department, it should be regarded as potentially dangerous, and must be sterilized by boiling before being used for drinking, cooking, or tooth-washing. Soda-water and 'soft drinks' are not trustworthy unless they are made from pure water, and inquiry should be made into the reliability of the materials and methods used by the makers The amount of alcohol present in some of the beers brewed by the indigenous people of the tropics is not enough to render them safe to drink The addition of whisky or other spirits, in the usual proportions, is not enough to make water or soda-water safe.

For *milk* the same is true, and all milk bought in the tropics should be boiled before use unless it is vouched for by the public health department Cows are often diseased (tuberculosis, undulant fever) and the organisms of these diseases may be present in the milk; milk is also an excellent culture material for germs which may enter it from the dirty hands or utensils of the herdsman. A small number of disease organisms may multiply to a very large number in a few hours, and the organisms of disease do not turn the milk sour, so that there is no clear indication of contamination except by laboratory tests. Therefore boil all milk.

For *meat* the precaution is thorough cooking Meat may be contaminated with bacteria or may contain the embryonic forms of certain worms To kill these it is necessary that cooking must be complete; underdone beef as we know it in England would be insufficiently cooked in the middle to kill all the worm embryos.

For *vegetables* which may have been grown on ground manured

used should be cotton, absorbent, and light. In malarious countries these open garments should be replaced in the evening by a garb which will protect against mosquitoes.

There is a common belief that in hot countries the abdomen is

although they cannot obviously have any influence on cholera); these certainly keep the abdomen warm, and they become impregnated with sweat. Those who wear these belts are usually convinced that without them they would suffer from diarrhoea. Those who do not use them can see no virtue in a thick, sticky garment covering part of the body that is no more susceptible to cold than any other. The writer has not seen any proof that body-belts are of the slightest value, but no doubt those who habitually use them would feel distressed if they discarded them. It is better for the newcomer to the tropics to avoid the habit, and to regard body-belts, like chest-protectors, as useless encumbrances.

On the other hand, it is perhaps wise to avoid too-sudden changes of temperature. For instance, after a vigorous game of tennis, football, or hockey, or even after the more sober exercise of cricket, it is advisable to sit for a time to cool off gradually, and drink to make up for lost fluid, before taking a warm or tepid bath, rather than to rush to a cold bath at once. The drink need contain no alcohol, for although alcohol in moderate amounts is no more harmful in the tropics than in temperate climates, it is no more necessary. Residents in tropical countries should be honest about alcohol, and admit that they take it (if they do) because they like it; they should

taken in the heat of the day, and whenever they are undertaken an adequate supply of fluid must be taken to avoid the depletion which is part of the condition of heat-exhaustion.

As a rule there is enough salt in a normal diet to provide what is necessary, but in countries where temperatures are *extremely* high, plenty of salt should be used at table, and drinks of salt water (1 teaspoonful to 1 pint) should be taken frequently during the day. So far from being unpleasant, these drinks are most refreshing under the existing conditions.

It is sometimes stated that diet should be restricted in hot countries because food tends to overload the liver. The writer knows no evidence to prove that this is so, but undoubtedly there is no need to eat as much in hot as in cold countries, because there is not the same need for heat production. Hunger is a good guide. If the bowels are sluggish it may be because the amount of fluid taken in is not enough; they should be stimulated by fruit and vegetables rather than by aperients.

Life in hot countries has many advantages, not the least of which are the sunshine and the beauty of the country-side; but it has disadvantages, of which sameness and intellectual isolation are important. The relief which changes of temperature bring in England is not common in hot countries, and long successions of hot, dry days and weeks tend to induce a state of exasperation. This irritation induced by sameness is not improved on small stations where residents see no more than the same few companions, at the same routine work or play, for long periods. Strained social relationships, or even overt quarrels, are common enough in these circumstances, and efficiency and contentment both suffer. Officers, especially on small stations, are often helped in these difficult relationships if they have some interest to which they can turn; if it is an interest on which they can do some research or inquiry, so much the better. A study of the habits and customs of the people, or of the local animals or plants, can be fascinating.

CHAPTER XXV

HEALTH POLICIES AND ORGANIZATION

THE Colonial Medical Service has grown from a small group doctors sent out to attend to the medical needs of the few officia stationed in the various tropical dependencies of the early days colonization, and it now comprises a large body of men and wome: Its function has also grown, so that at the present time the maj part of the duties of medical officers is the care of the inhabitan of the various countries; and attention to the officials, though sti a primary duty, forms only a small proportion of the work don A very important duty consists in the training of local men doctors, and in East and West Africa, the Sudan, Malaya, Fiji, an other places there are well-organized medical schools in whic medical training is given to a considerable number of youn people, in courses lasting five years or more, of high profession standing. Some of the qualifications bear comparison with thos given by British universities, and some of the examinations ar conducted under the supervision of eminent physicians or surgeon chosen for the purpose by the Royal Colleges of Physicians an Surgeons. The qualifications given at certain of these medic schools, on the other hand, are as yet somewhat below the hom standard, and this is a deliberate policy to avoid setting so hig a standard that it could hardly be attained by candidates with th present background of elementary education. The intention i gradually to raise the standard of medical education, but in th meantime to give qualifications which will at least ensure a reasonable minimum of skill and experience in those who pass the examinations Experience has proved that most of the men who pas out of these medical schools are perfectly capable of taking ful charge of small hospitals, and of carrying out the duties of medical officers They are carefully trained by selected officers of the medical services of the countries concerned, who take a persona interest in their students which is of the greatest value. Refreshe courses are arranged for men who have been qualified several years

In addition to the education of doctors, the members of the Colonial Medical Service and many medical missions train dispensers, nurses, midwives, pharmacists, laboratory assistants, sani-

tary inspectors, and health visitors, in large numbers These persons are subsequently posted to government hospitals, clinics or health departments, or to mission hospitals; or they engage in private work. But the point is that although as yet the numbers of men and women who have completed their training are much below the needs of the various countries, there is a growing body of trained medical assistants, throughout the tropics, who will continue to exercise an increasingly important influence on the people. Through them and through the schools will be introduced to the mass of the people those ideas of medical progress which will eventually supplant the still-prevalent belief in witchcraft which, in spite of some virtues, continues to hold back the physical and mental development of many of the peoples

The organization of the colonial medical services is well known The Secretary of State for the Colonies exercises control, in various degrees, over the government services of the colonies, and retains the services of medical advisers to assist him, as the agricultural and other advisers assist him in their own subjects In the colonies themselves there are medical departments each of which, through the Director of Medical Services (or the Senior Medical Officer) is responsible to the Governor The medical department usually includes three main sections the treatment service (which is responsible for hospitals and dispensaries), the public health service (concerned with general sanitation and preventive measures), and the laboratory service (which deals with examination of biological material, water, and food, and with medico-legal work) Special branches are included in the medical departments of certain countries, for instance, there are the medical entomologists, whose work is of the greatest importance, the nutrition units, the sleeping-sickness teams, &c. In recent years new activities have been inaugurated, which are chiefly concerned with the resettlement of the people in areas of Africa freed from tsetse flies, or with the intensive study of the people in their own surroundings These activities usually involve several departments—medical, agricultural, forestry, veterinary, education—and for efficient working they should receive the active support and direction of the administrative staff. It is important that the administrative officer should take the advice of the different experts, and where the advice conflicts, resolve the differences as equitably as he can. He himself is the expert on matters of law and tribal custom, and he can usually assess better

than most the effects of any suggested activities on the minds of the people. It will probably fall to him to win over a suspicious and conservative population, who may not be easily susceptible to reasoned argument, but more so to a mixture of tactful suggestion and of firmness. In many ways his is the most difficult part, in that the success of most of these schemes depends upon the maintenance of enthusiasm and goodwill in the departmental staffs, and of a co-operative spirit in the people, and these depend on the personality of the administrative officer, who co-ordinates the whole. He, more than most, needs the personal touch But he is not the expert in medicine or the other sciences, and he should not attempt to form opinions or enforce policies in matters outside his competence. Departmental jealousies and personal prejudices are common in the tropics; but if these are allowed to interfere with efficiency or smooth working, the officer concerned fails in his duty. It is, of course, a counsel of perfection, but it is true to say that the administrative officer should be sufficiently statesmanlike to submerge his personal feelings if they conflict with the progress of the work or the harmony of the team. It is true of the other officers also, but especially so of the administrative officer, who holds great power and who can set the tone.

There is a very natural tendency for officers in all departments of government service to think that their work is hampered by lack of funds and lack of staff; and this is true The medical department may have no more than one doctor for 20,000 or more of the population, and subordinate staff in the same proportion, and the department will necessarily press continually for a larger share in the total government budget. The same is true, with equal justice, of many other departments. It is therefore necessary for the senior officers, and the secretariat and treasury, to attempt a wise distribution of the available funds between the departments. The medical department may press the argument that good health is an end in itself and also an indispensable means to prosperity and happiness; and may therefore argue that more hospitals, health schemes, and [illegible] department may argue that

[illegible]

administration may contend that increase of cash crops or of industrial enterprise will most usefully serve the general good by increasing wealth through trade and thus enabling improvement

to be made in the standard of living. It is true that final decisions on the merits of these arguments must be taken at high levels, but the district officers are often in the best position to see in practice the effects of policies on the people, and to convey their views in the reports they make to their seniors.

Apart from the regular medical services of certain tropical countries there have been developed special branches designed for particular purposes In the British countries the sleeping-sickness teams, the yaws teams, and the other special groups, the various commissions or research workers sent out from Britain (under the auspices of the Royal Society and the Medical Research Council, for instance), and the teams from the Rockefeller Foundation of the United States, are cases in point. They usually work in close association with the general medical services. The same is true of the sometimes extensive mission or industrial medical organizations (for instance, the medical service of the ground-nut undertakings in East Africa) The missions are often subsidized by government because they treat the general population or undertake the permanent care of advanced leprosy patients, or train dispensers, nurses, and dressers Medical missionaries play a very important part in the curative medical services of hot countries, and by the circumstances of their constitution, they are often able to study more closely than the government officers the course of disease for long periods in a group of people whose history is known in detail Missions usually keep records of their people The missionaries know their homes and their families, often through several generations, more intimately than is usually possible for government officers. The records of births, deaths and marriages stored in mission registers may be a most important source of information on the vital statistics of primitive people, so often lacking in the tropics

Private medical practitioners are becoming more numerous in the colonies; they also have an important share in the curative services of those countries.

But in some countries new schemes are on trial, and some of these are obviously most valuable In the Belgian Congo a fund has been used to found a service known as Foréami, from the initial letters of its full title *Fonds Reine Élisabeth pour l'Assistance Médicale aux Indigènes* This consists of a large number of doctors, sanitary inspectors, orderlies, &c., who enter an area of the country,

map it, and systematically register and medically examine all persons in it, treating those who need treatment, and re-examining all the people at intervals. Such dispensaries and other buildings as are needed are constructed. In addition to curative medicine, an attempt is made to educate the people in the principles of sanitation and the general means of prevention of disease. The intention is that after a period of a few years the health and education of the people will be so improved that the team can move on to a new district, leaving the people to the less intense care of the regular medical services This organization is undoubtedly a great success in spite of the fact that, in the places where it has operated, the large amount of trypanosomiasis encountered, and the other conditions met, have necessitated a much longer stay in each area than was at first intended.

In British countries there has been a development of smaller schemes than this, having somewhat different objects. These are the health units, which may be stationary (attached to a hospital or in smaller buildings of their own) or mobile. These units consist usually of small teams, and their functions differ in various countries. They often conduct special clinics for maternity and child welfare, and always give such treatment as is within their capacity, but their main functions are to educate the people in all the principles of good sanitation, water and food supply, and to vaccinate them against small-pox and other relevant diseases. These health units penetrate into the rural areas, and are usually so linked by transport facilities with the larger hospitals and public health centres that there is a reasonably close medical network for the assistance of the people of the areas in which they work. The network is by no means close enough, and the services provided are nowhere on a scale sufficient for the needs, but the beginning has been made, and the system, undoubtedly efficient, can be expanded indefinitely as trained staff and equipment become available. The continued success of health units will chiefly depend upon the skill and enthusiasm of the trained local staffs.

In all tropical countries there are small dispensaries and dressing-stations, under the care of locally trained men, at which simple treatment for common ailments can be obtained. The standard of efficiency at these places necessarily varies very greatly with the personalities of the men in charge, and with the degree of supervision given by medical and administrative officers. If the people

themselves, and their chiefs, have found the value of the treatment given, they themselves will demand a reasonable standard of efficiency, but the dispenser may encounter opposition from medicine men, which may make his work difficult. Sanitary inspectors are also stationed in small villages away from European support and control. Their work is hard in that they must instruct the people in a system of cleanliness and tidiness which is contrary to custom and which holds no obvious immediate advantage. They must use some pressure to make the people do unpopular tasks, and, because of this, they cannot be expected to succeed so well as the dispensers who do obvious good to those who need attention. Nevertheless, the work of the sanitary inspectors is very important, and they should be supported and supervised. Administrative officers can do incalculable good if they encourage these men and give them open support.

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